United States Department of the Interior

FISH AND WILDLIFE SERVICE
South Florida Ecological Services Office
1339 20th Street
Vero Beach, Florida 32960

March 14, 2005

Marie G. Burns
U.S. Army Corps of Engineers
South Permits Branch
701 San Marco Boulevard, Room 372
Jacksonville, Florida 32207-8175

Service Log No.:	4-1-04-F-6342
Application No.:	SAJ-1988-290 (IP-MN)
Dated:	October 20, 2000
Applicant:	Collier County Board of County Commissioners
County:	Collier

Dear Ms. Burns:

This document transmits the Fish and Wildlife Service's (Service) biological opinion based on our review of the proposed Hideaway Beach beach renourishment and permanent T-head groin (T-groin) construction and associated dredging project located on Royal Marco and South Point Beaches in Collier County, Florida, and its effects on the nesting loggerhead (*Caretta caretta*), leatherback (*Dermochelys coriacea*), and green sea turtles (*Chelonia mydas*) as well as the piping plover (*Charadrius melodus*) and West Indian manatee (*Trichechus manatus*) in accordance with section 7 of the Endangered Species Act of 1973, as amended (ESA) (87 Stat. 884; 16 U.S.C. 1531 *et seq.*). The U.S. Army Corps of Engineers' (Corps) request for formal consultation was received on March 1, 2004.

This biological opinion is based on information provided in the October 20, 2000, project proposal, the August 2003 Hideaway Beach Erosion Control Project Joint Coastal Permit Application prepared by Humiston and Moore Engineers, biological assessments, meetings with the applicant's representatives and consultants, field investigations, and other sources of information. A complete administrative record of this consultation is on file at the Service's South Florida Ecological Services Office in Vero Beach, Florida.

In an email dated December 17, 2004, the Corps determined that the proposed project "may affect, but is not likely to adversely affect" the threatened piping plover. The project is located adjacent to Florida Unit 27 of piping plover designated critical habitat and the Corps provided a determination that the project was unlikely to destroy or adversely modify that designated critical habitat. The proposed project may result in additional habitat available to foraging or loafing piping plovers and other shorebirds. Collier County Natural Resources Department (CCNRD) noted shorebird use in the vicinity of the existing T-groins. In addition, the applicant has agreed to implement a shorebird monitoring and protection plan approved by the Florida Fish and Wildlife Conservation Commission (FWC) and Florida Department of Environmental Protection (DEP). Based on this information, the Service concurs with the Corps' determination. As a result, effects to the piping plover or its designated critical habitat will not be analyzed in detail in this biological opinion.

Consultation History

The Service commented on the construction of five temporary groins at the project site in a letter dated December 23, 1996. Concerns as stated in that correspondence included the sensitivity of the project shoreline relative to proximity to the state-designated Big Marco Pass Critical Wildlife Area (BMPCWA) to the southwest, an important sea turtle nesting area

On January 30, 1997, the Service responded to a November 26, 1996, Corps Public Notice regarding construction of five, 100-foot temporary T-groins of geotextile sand-filled bags. The Corps requested formal consultation on nesting sea turtles. Based on the timing of the proposed work outside the sea turtle nesting season, the Service concurred with the Corps' determination that the project "may affect, but was not likely to adversely affect" nesting sea turtles. The Service also concluded that the project "may affect, but was not likely to adversely affect" the West Indian manatee based on the Corps' inclusion of the *Standard Manatee Construction Conditions* as special conditions of the permit. Based on input from the former Florida Game and Fresh Water Fish Commission (FWC) dated December 23, 1996, the Service requested additional information on the bald eagle (*Haliaeetus leucocephalus*) and piping plover, primarily associated with potential effects to the adjacent FWC-managed BMPCWA.

On February 19, 1997, the Service attended an interagency site inspection with the applicant and Humiston and Moore Engineers (HME). The site inspection documented 700 feet of shoreline that had been fortified with a three-layer deep row of sandbags, originally placed above mean high water but located below mean high water due to subsequent shoreline erosion. Based on an agreement to remove these sandbags, conditioned as part of the Corps' permit, the Service did not revise the concurrence effects to sea turtles. Based on a March 11, 1997, verbal agreement with the Corps that the temporary groins would be removed if adverse effects were noted in BMPCWA and adjacent areas, the Service concurred that the project "may affect, but was not likely to adversely affect" the piping plover, bald eagle, and roseate tern (*Sterna dougallii dougallii*).

In a letter dated March 20, 1997, the FWC recommended project monitoring and other project conditions to assess and minimize the project's effects on the BMPCWA.

On March 24, 1997, the Corps notified the Service that the project would require work within the sea turtle nesting season and determined that the project "may adversely affect" nesting sea turtles.

On April 30, 1997, the Service responded to the March 24, 1997, Corps letter, citing correspondence from HME dated April 15 and 16, 1997, outlining measures to protect sea turtles during construction (predicted to begin May 13 and end July 5, 1997) in the sea turtle nesting season. Based on these measures, the Service concluded that the project "may affect, but was not likely to adversely affect" nesting sea turtles.

On July 18, 1997, HME notified the Corps that the project needed to be modified to shorten the length of three of the five temporary groins and change the location of sand fill deposition due to shoreline erosion; two temporary groins have been completed. On July 21, 1997, HME notified the Service of the modification and the location of two sea turtle nests in the project area. On July 25, 1997, the Corps approved the modification. Groin construction was completed in 1997.

On April 18, 2000, the Service received a letter from the FWC to the DEP expressing concern regarding the effects of new groin construction on nesting sea turtles and requesting additional information.

The Service received Corps permit pre-application information dated April 27, September 25, and October 11, 2000, from HME regarding the construction of two additional temporary groins.

On October 20, 2000, the Service received a permit application for additional temporary groin construction, beach fill, and dredging of Collier Bay. The Corps determined that the project "may affect, but was not likely to adversely affect" nesting sea turtles and would have "no effect" on the West Indian manatee based on the use of the Standard Manatee Construction Conditions. No determination was made for the piping plover.

The Service received a second letter from the FWC dated October 24, 2000, expressing concern regarding temporary groin design and removal of shoals at Royal Marco Point (Collier Bay) for beach fill.

The Service participated in a meeting with the applicant and HME to discuss the project and request additional information on October 30, 2000. The Corps was unable to attend due to a meeting conflict.

On November 3 and 17, 2000, the Service received sea turtle nesting, manatee, and piping plover information as requested at the October 30, 2000, meeting.

On November 15, 2000, the Service performed a site inspection of the referenced site with the applicant, HME, and Hideaway Beach representatives.

The Service received a copy of correspondence from HME to DEP dated November 21, 2000, regarding structure design, project history, and sea turtle nesting information at the project site.

The Service responded to the Corps' public notice in a letter dated November 20, 2000, expressing concern for temporary groin construction effects on nesting sea turtles; piping plover habitat at the site adjacent BMPCWA and Coconut Island seaward of the project; and construction effects on the West Indian manatee. The Service did not concur with the Corps' determination on sea turtles and requested additional information in order to initiate formal consultation. The Service also requested additional information on the West Indian manatee in order to concur with the Corps' determination, and requested an effect determination and additional information on potential effects to the piping plover at the site.

The Service received a copy of correspondence from HME to the Corps dated December 22, 2000, responding to the November 20, 2000, Service letter requesting additional information on listed species at the site. The Service also received information attached to a template biological opinion on December 22, 2000, from HME.

On February 21, 2001, the Corps provided a "may affect, but was not likely to adversely affect" determination for the West Indian manatee and piping plover based on additional information provided by the applicant, and requested formal consultation on nesting sea turtles.

On February 27, 2001, HME requested an extension of the construction window to June 30, 2001, proposing work within the sea turtle nesting season for the 2001 nesting season.

On March 22, 2001, the Service was advised that additional beach renourishment, consistent with a separate Corps permit, was pending. The Service advised the Corps that this work "may adversely affect" nesting green and loggerhead sea turtles and requested that the Corps reinitiate consultation on the previously issued permit. The Service and the Corps agreed that additional renourishment and repair or addition to previously constructed temporary groins at the project location (Hideaway Beach) would be addressed by this biological opinion.

On April 5, 2001, the Service concurred with the Corps' determination for the West Indian manatee and piping plover, and initiated formal consultation on nesting sea turtles. The Corps stated that the standard protection measures for protection of the manatee would be implemented for any in-water work associated with the project.

On April 6, 2001, the Service provided a biological opinion (Service log number 4-1-97-F-343) for the dredging of approximately 18,000 cubic yards (cy) of sand from the entrance to Collier Bay and construct two new temporary T-groins, one at South Point and the other at Royal Marco Point.

The Corps issued a Public Notice on February 28, 2004, to remove the temporary T-groins, install 10 permanent T-groins, and place sand on Hideaway Beach between DEP monuments T-128 and H-13.5.

BIOLOGICAL OPINION

DESCRIPTION OF THE PROPOSED ACTION

The applicant is proposing to renourish 1.4 miles of Hideaway Beach and replace the existing temporary T-groins (Figure 1) with 10 new sheet pile T-groins with energy absorbing limestone riprap aprons on the seaward side (five at Royal Marco Point between DEP monuments H-9 and H-12, and five at South Point from south of DEP monument H-1 to south of H-5) (Figure 2).

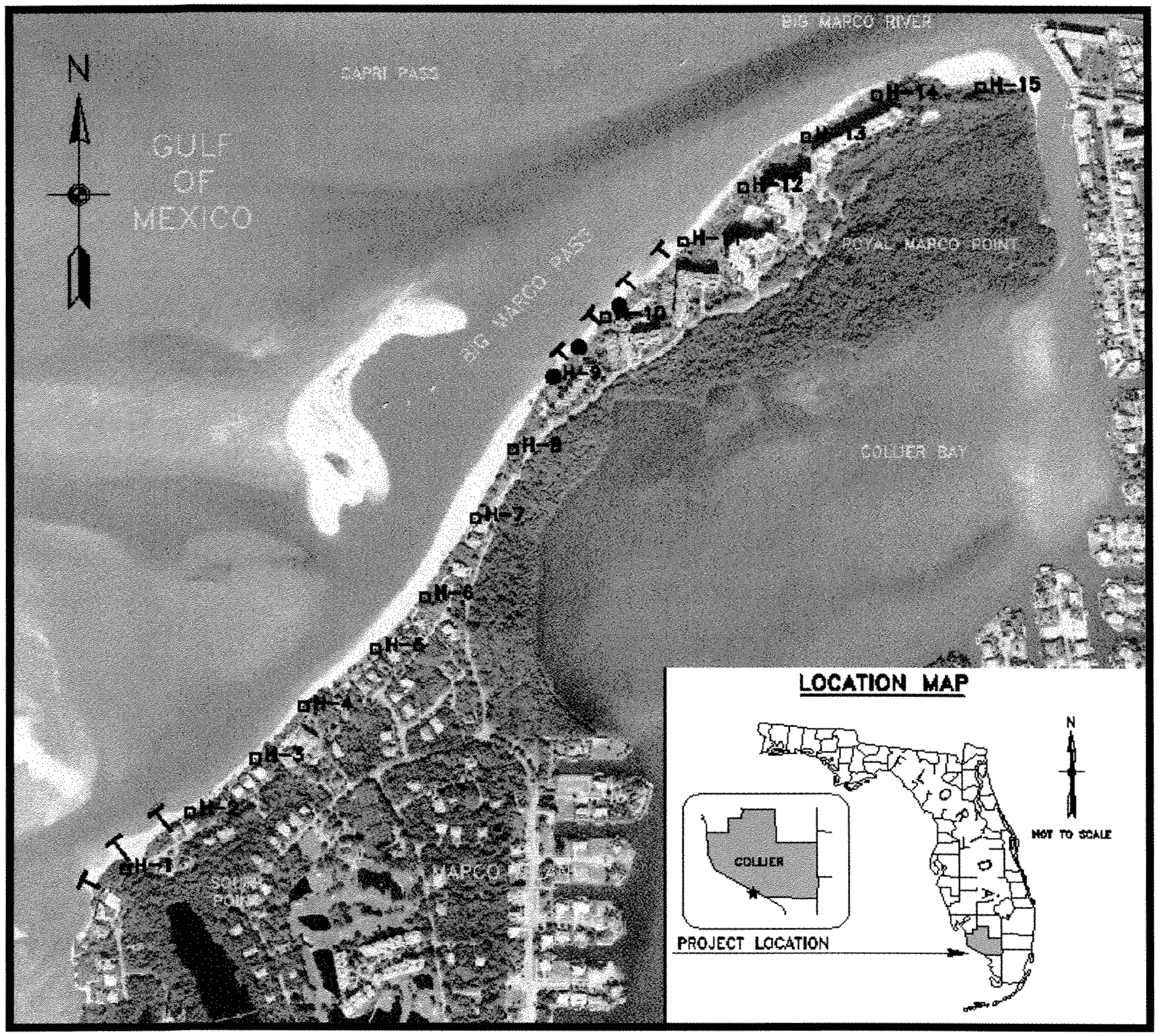

Figure 1. Hideaway Beach project location and existing temporary groin locations.

Specifically, the applicant has proposed to dredge approximately 546,000 cy of sand from Marco Pass shoal (Figure 3) to a depth of -12 feet National Geodetic Verticle Datum (NGVD) at Cut 1 and -18 feet NGVD at Cut 2. This material will be used to renourish the beach in the vicinity of the T-groins. In conjunction with these activities, 133,000 cy of beach quality sand will be placed between markers T-128 and H-7 (South Point). Approximately 107,000 cy of beach sand will be placed between markers H-8 and H-13.5 (Royal Marco Point). Construction time for the T-groins is approximately 150 days. Therefore, there is a potential for the project to be constructed during the 2005 sea turtle nesting season. The application indicates that there are no seagrass beds or hardbottom communities in the project area. The project is located southwest of Big Marco Pass, at the entrance to Collier Bay and at Hideaway Beach in Sections 5, 6, and 7, Township 52 South, Range 26 East, Marco Island, Collier County, Florida.

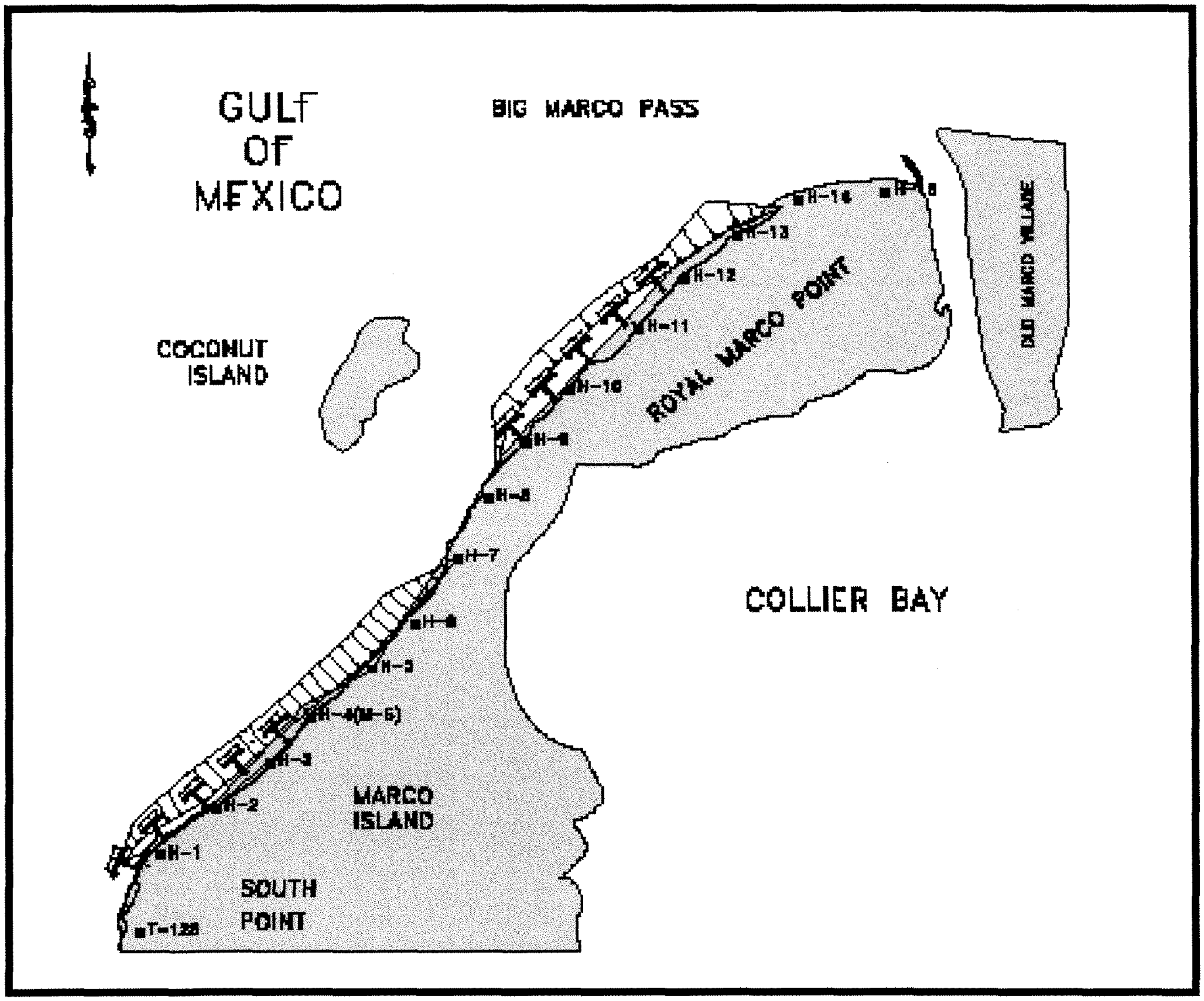

Figure 2. Proposed T-groin locations for Hideaway Beach project.

The permanent T-groins would be fabricated from sheet metal and have energy absorbing aprons on the seaward side of the T-groin. There is a weir at the terminus of the T-groin in the center of the T-head. The weir is at elevation 0.0 NGVD. The T-head weir elevation is approximately midway between mean low water and mid tide level, and will therefore be submerged approximately 75 percent of a mean tidal cycle. It will transmit wave energy under virtually all wave conditions which contribute to sand transport in order to allow wave energy to prevent formation of a tombolo (prominent sand feature that meets the T-head) behind the center of the T-head.

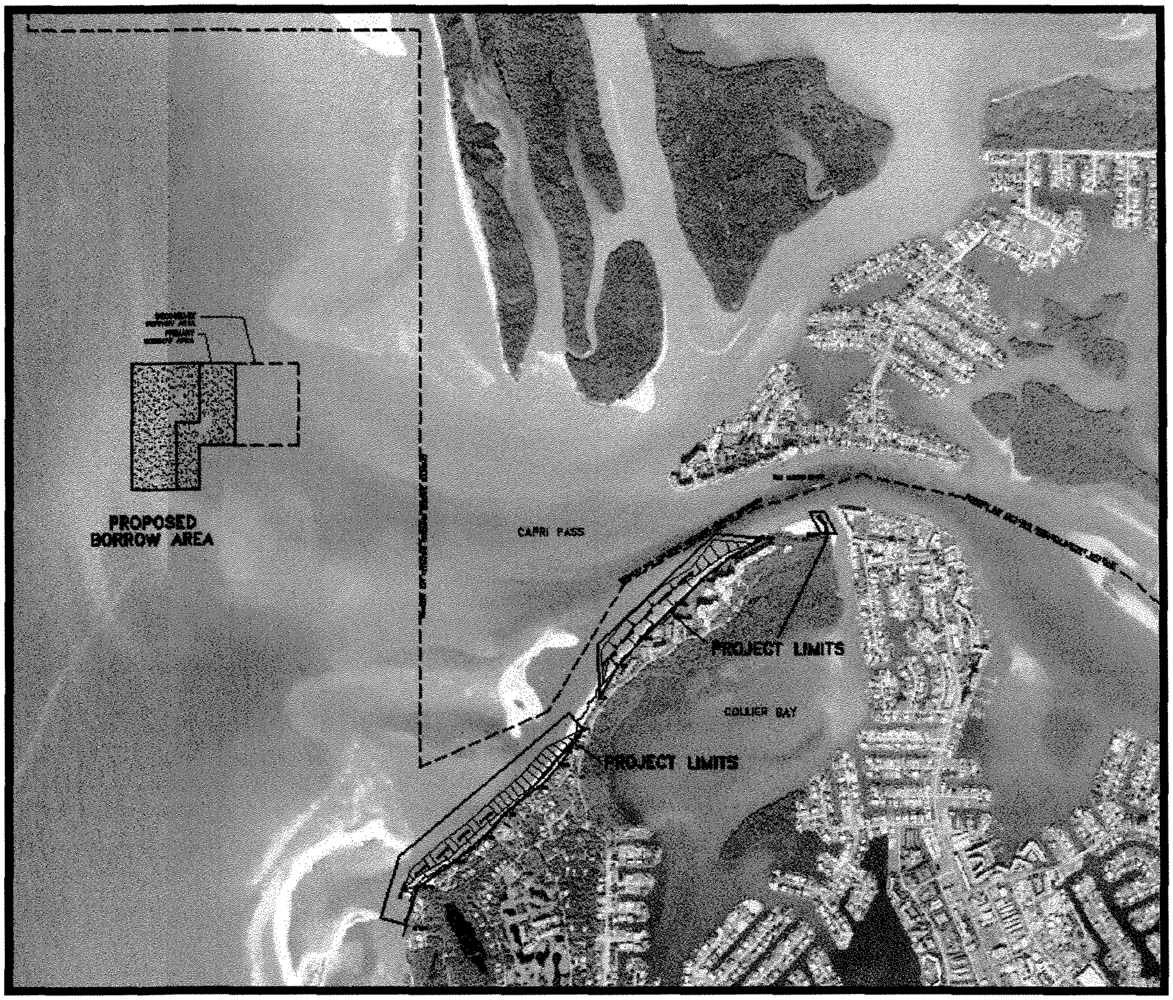

Figure 3. Borrow area location for Hideaway Beach T-groin project.

The shore perpendicular trunk element steps down to elevation -0.5 feet NGVD where it connects to the T-head. This is essentially a trunk weir directly behind the T-head weir; in combination they provide the wave energy to transport sand and a pathway for the sand to move past the structure. The trunk weir is at elevation -0.5 NGVD, which is approximately mean low water, and is therefore submerged on all but the lowest water levels around spring tides. The low profile design of the trunk weir allows lateral sand transport behind and around the structure to minimize potential obstruction of sea turtle hatchlings in the vicinity of the T-groins.

The crest of the T-head on either side of the weir is at elevation 2.2 feet NGVD. This is approximately 0.5 feet above mean high water. This portion of the structure is emergent during normal tidal cycles but will routinely be overtopped by wave action, particularly during storms and spring tides, and in general any wave condition that contributes significantly to longshore sand transport.

A monitoring plan has been submitted to the DEP and will be included as a part of the project. It may also be viewed at http://www.humistonandmoore.com/12028/Physical-Seagrass%20Monitoring%20Plan.pdf and through http://bcs.dep.state.fl.us/env-prmt/collier/issued/ upon permit issuance, permit number 0222764-001-JC.

Action Area

The action area is defined as all areas to be affected directly or indirectly by the Federal action and not merely the immediate area involved in the action. The Service has determined that the action area for this project includes 1.4 miles of Hideaway Beach shoreline between DEP monuments T-128 and H-15 on Marco Island in Sections 5, 6, and 7, Township 52 South, Range 26 East (Figure 2).

STATUS OF THE SPECIES AND CRITICAL HABITAT RANGEWIDE

Species/Critical Habitat Description

Loggerhead Sea Turtle

The loggerhead sea turtle, listed as a threatened species on July 28, 1978 (43 FR 32800), inhabits the continental shelves and estuarine environments along the margins of the Atlantic, Pacific, and Indian Oceans. Loggerhead sea turtles nest within the continental United States (U.S.) from Louisiana to Virginia. Major nesting concentrations in the U.S. are found on the coastal islands of North Carolina, South Carolina, and Georgia, and on the Atlantic and Gulf Coasts of Florida (Hopkins and Richardson 1984).

No critical habitat has been designated for the loggerhead sea turtle.

Green Sea Turtle

The green sea turtle was federally listed as a protected species on July 28, 1978 (43 FR 32800). Breeding populations of the green turtle in Florida and along the Pacific Coast of Mexico are listed as endangered; all other populations are listed as threatened. The green turtle has a worldwide distribution in tropical and subtropical waters. Major green turtle nesting colonies in the Atlantic occur on Ascension Island, Aves Island, Costa Rica, and Surinam. Within the U.S., green turtles nest in small numbers in the U.S. Virgin Islands and Puerto Rico, and in larger numbers along the east coast of Florida, particularly in Brevard, Indian River, St. Lucie, Martin, Palm Beach, and Broward Counties (National Marine Fisheries Service [NOAA Fisheries] and Service 1991a). Nesting also has been documented along the Gulf Coast of Florida on Santa Rosa Island (Okaloosa and Escambia Counties) and from Pinellas County through Collier County (FWC statewide nesting database). Green turtles have been known to nest in Georgia, but only on rare occasions (Georgia Department of Natural Resources statewide nesting database). The green turtle also nests sporadically in North Carolina and South Carolina (North Carolina Wildlife Resources Commission statewide nesting database; South Carolina

Department of Natural Resources statewide nesting database). Unconfirmed nesting of green turtles in Alabama has also been reported (Bon Secour National Wildlife Refuge nesting reports).

Critical habitat for the green sea turtle has been designated for the waters surrounding Culebra Island, Puerto Rico, and its outlying keys.

Leatherback Sea Turtle

The leatherback sea turtle, listed as an endangered species on June 2, 1970 (35 FR 8491), nests on shores of the Atlantic, Pacific, and Indian Oceans. Non-breeding animals have been recorded as far north as the British Isles and the Maritime Provinces of Canada and as far south as Argentina and the Cape of Good Hope (Pritchard 1992). Nesting grounds are distributed worldwide, with the Pacific Coast of Mexico supporting the world's largest known concentration of nesting leatherbacks. The largest nesting colony in the wider Caribbean region is found in French Guiana, but nesting occurs frequently, although in lesser numbers, from Costa Rica to Columbia and in Guyana, Surinam, and Trinidad (NOAA Fisheries and Service 1992; National Research Council 1990).

The leatherback regularly nests in the U.S. in Puerto Rico, the U.S. Virgin Islands, and along the Atlantic coast of Florida as far north as Georgia (NOAA Fisheries and Service 1992). Leatherback turtles have been known to nest in Georgia, South Carolina, and North Carolina, but only on rare occasions (North Carolina Wildlife Resources Commission, South Carolina Department of Natural Resources, and Georgia Department of Natural Resources statewide nesting databases). Leatherback nesting also has been reported on the northwest coast of Florida (LeBuff 1990; FWC statewide nesting database); a false crawl (non-nesting emergence) has been observed on Sanibel Island (LeBuff 1990).

Marine and terrestrial critical habitat for the leatherback sea turtle has been designated at Sandy Point on the western end of the island of Saint Croix, U.S. Virgin Islands.

Life History

Loggerhead Sea Turtle

Loggerheads are known to nest from one to seven times within a nesting season (Talbert et al. 1980; Richardson and Richardson 1982, Lenarz et al. 1981; among others); the mean is approximately 4.1 (Murphy and Hopkins 1984). The interval between nesting events within a season varies around a mean of about 14 days (Dodd 1988). Mean clutch size varies from about 100 to 126 along the southeastern U.S. coast (NOAA Fisheries and Service 1991b). Nesting migration intervals of 2 to 3 years are most common in loggerheads, but the number can vary from 1 to 7 years (Dodd 1988). Age at sexual maturity is believed to be about 20 to 30 years (Turtle Expert Working Group 1998).

Green Sea Turtle

Green turtles deposit from one to nine clutches within a nesting season, but the overall average is about 3.3. The interval between nesting events within a season varies around a mean of about 13 days (Hirth 1997). Mean clutch size varies widely among populations. Average clutch size reported for Florida was 136 eggs in 130 clutches (Witherington and Ehrhart 1989). Only occasionally do females produce clutches in successive years. Usually 2, 3, 4, or more years intervene between breeding seasons (NOAA Fisheries and Service 1991a). Age at sexual maturity is believed to be 20 to 50 years (Hirth 1997).

Leatherback Sea Turtle

Leatherbacks nest an average of 5 to 7 times within a nesting season, with an observed maximum of 11 (NOAA Fisheries and Service 1992). The interval between nesting events within a season is about 9 to 10 days. Clutch size averages 80 to 85 yolked eggs, with the addition of usually a few dozen smaller, yolkless eggs, mostly laid toward the end of the clutch (Pritchard 1992). Nesting migration intervals of 2 to 3 years were observed in leatherbacks nesting on the Sandy Point National Wildlife Refuge, Saint Croix, U.S. Virgin Islands (McDonald and Dutton 1996). Leatherbacks are believed to reach sexual maturity at 6 to 10 years (Zug and Parham 1996).

Population Dynamics

Loggerhead Sea Turtle

Total estimated nesting in the southeast are approximately 68,000 to 90,000 nests per year, according to the FWC statewide nesting database 2002, Georgia Department of Natural Resources statewide nesting database 2002, South Carolina Department of Natural Resources statewide nesting database 2002, and the North Carolina Wildlife Resources Commission statewide nesting database 2002. In 1998, there were over 80,000 nests in Florida alone. From a global perspective, the southeastern U.S. nesting aggregation is of paramount importance to the survival of the species and is second in size only to that which nests on islands in the Arabian Sea off Oman (Ross 1982; Ehrhart 1989; NOAA Fisheries and Service 1991b). The status of the Oman colony has not been evaluated recently, but its location in a part of the world that is vulnerable to disruptive events (*e.g.,* political upheavals, wars, catastrophic oil spills) is cause for considerable concern (Meylan et al. 1995). The loggerhead nesting aggregations in Oman, the southeastern U.S., and Australia account for about 88 percent of nesting worldwide (NOAA Fisheries and Service 1991b). About 80 percent of loggerhead nesting in the southeastern U.S. occurs in six Florida counties (Brevard, Indian River, St. Lucie, Martin, Palm Beach, and Broward Counties) (NOAA Fisheries and Service 1991b).

Green Sea Turtle

About 150 to 2,750 females are estimated to nest on beaches in the continental U.S. annually (FWC 2003). In the U.S. Pacific, over 90 percent of nesting throughout the Hawaiian Archipelago occurs at the French Frigate Shoals, where about 200 to 700 females nest each year

(NOAA Fisheries and Service 1998). Elsewhere in the U.S. Pacific, nesting takes place at scattered locations in the Commonwealth of the Northern Marianas, Guam, and American Samoa. In the western Pacific, the largest green turtle nesting aggregation in the world occurs on Raine Island, Australia, where thousands of females nest nightly in an average nesting season (Limpus et al. 1993). In the Indian Ocean, major nesting beaches occur in Oman where 30,000 females are reported to nest annually (Ross and Barwani 1995).

Leatherback Sea Turtle

Recent estimates of global nesting populations indicate 26,000 to 43,000 nesting females annually (Spotila et al. 1996). The largest nesting populations at present occur in the western Atlantic in French Guiana (4,500 to 7,500 females nesting/year) and Colombia (estimated several thousand nests annually), and in the western Pacific in West Papua (formerly Irian Jaya) and Indonesia (about 600 to 650 females nesting/year). In the U.S., small nesting populations occur on the Florida east coast (100 females/year) (FWC 2003), Sandy Point, U.S. Virgin Islands (50 to 190 females/year) (Alexander et al. 2002) and Puerto Rico (30 to 90 females/year).

Status and Distribution

Loggerhead Sea Turtle

Genetic research involving analysis of mitochondrial DNA has identified five different loggerhead subpopulations/nesting aggregations in the western North Atlantic: (1) the Northern Subpopulation occurring from North Carolina to around Cape Canaveral, Florida (about 29 degrees North.); (2) South Florida Subpopulation occurring from about 29 degrees North on Florida's east coast to Sarasota on Florida's west coast; (3) Dry Tortugas, Florida Subpopulation; (4) Northwest Florida Subpopulation occurring at Eglin Air Force Base and the beaches near Panama City; and (5) Yucatán Subpopulation occurring on the eastern Yucatán Peninsula, Mexico (Bowen 1994, 1995; Bowen et al. 1993; Encalada et al. 1998; Pearce 2001). These data indicate that gene flow between these five regions is very low. If nesting females are extirpated from one of these regions, regional dispersal will not be sufficient to replenish the depleted nesting subpopulation. The Northern Subpopulation has declined substantially since the early 1970s, but most of that decline occurred prior to 1979. No significant trend has been detected in recent years (Turtle Expert Working Group 1998, 2000). Adult loggerheads of the South Florida Subpopulation have shown significant increases over the last 25 years, indicating that the population is recovering, although a trend could not be detected from the State of Florida's Index Nesting Beach Survey program from 1989 to 2002. Nesting surveys in the Dry Tortugas, Northwest Florida, and Yucatán Subpopulations have been too irregular to date to allow for a meaningful trend analysis (Turtle Expert Working Group 1998, 2000).

Threats include incidental take from channel dredging and commercial trawling, longline, and gill net fisheries; loss or degradation of nesting habitat from coastal development and beach armoring; disorientation of hatchlings by beachfront lighting; excessive nest predation by native and non-native predators; degradation of foraging habitat; marine pollution and debris;

watercraft strikes; and disease. There is particular concern about the extensive incidental take of juvenile loggerheads in the eastern Atlantic by longline fishing vessels from several countries.

Green Sea Turtle

Total population estimates for the green turtle are unavailable, and trends based on nesting data are difficult to assess because of large annual fluctuations in numbers of nesting females. For instance, in Florida, where the majority of green turtle nesting in the southeastern U.S. occurs, estimates range from 150 to 2,750 females nesting annually (FWC 2003). Populations in Surinam and Tortuguero, Costa Rica, may be stable, but there is insufficient data for other areas to confirm a trend.

A major factor contributing to the green turtle's decline worldwide is commercial harvest for eggs and food. Fibropapillomatosis, a disease of sea turtles characterized by the development of multiple tumors on the skin and internal organs, is also a mortality factor and has seriously impacted green turtle populations in Florida, Hawaii, and other parts of the world. The tumors interfere with swimming, eating, breathing, vision, and reproduction, and turtles with heavy tumor burdens may die. Other threats include loss or degradation of nesting habitat from coastal development and beach armoring; disorientation of hatchlings by beachfront lighting; excessive nest predation by native and non-native predators; degradation of foraging habitat; marine pollution and debris; watercraft strikes; and incidental take from channel dredging and commercial fishing operations.

Leatherback Sea Turtle

Declines in leatherback nesting have occurred over the last two decades along the Pacific coasts of Mexico and Costa Rica. The Mexican leatherback nesting population, once considered to be the world's largest leatherback nesting population (65 percent of worldwide population), is now less than 1 percent of its estimated size in 1980. Spotila et al. (1996) recently estimated the number of leatherback sea turtles nesting on 28 beaches throughout the world from the literature and from communications with investigators studying those beaches. The estimated worldwide population of leatherbacks in 1995 was about 34,500 females on these beaches with a lower limit of about 26,200 and an upper limit of about 42,900. This is less than one third the 1980 estimate of 115,000. Leatherbacks are rare in the Indian Ocean and in very low numbers in the western Pacific Ocean. The largest population is in the western Atlantic. Using an age-based demographic model, Spotila et al. (1996) determined that leatherback populations in the Indian Ocean and western Pacific Ocean cannot withstand even moderate levels of adult mortality and that even the Atlantic populations are being exploited at a rate that cannot be sustained. They concluded that leatherbacks are on the road to extinction and further population declines can be expected unless we take action to reduce adult mortality and increase survival of eggs and hatchlings.

The crash of the Pacific leatherback population is believed primarily to be the result of exploitation by humans for the eggs and meat, as well as incidental take in numerous commercial fisheries of the Pacific. Other factors threatening leatherbacks globally include loss or degradation of nesting habitat from coastal development; disorientation of hatchlings by beachfront lighting; excessive nest predation by native and non-native predators; degradation of foraging habitat; marine pollution and debris; and watercraft strikes.

Analysis of the species likely to be affected

The proposed action has the potential to adversely affect nesting females, nests, and hatchlings within the proposed project area. The proposed action has also been demonstrated through project monitoring to be beneficial to sea turtle nesting habitat. The effects of the proposed action on sea turtles will be considered further in the remaining sections of this biological opinion. Potential effects include destruction of nests deposited within the boundaries of the proposed project, harassment in the form of disturbing or interfering with female turtles attempting to nest within the construction area or on adjacent beaches as a result of construction activities, disorientation of hatchling turtles on beaches within or adjacent to the construction area as they emerge from the nest and crawl to the water as a result of T-groin location, and behavior modification of nesting females due to the temporary T-groin location within the project area during a nesting season, resulting in false crawls or situations where they choose marginal or unsuitable nesting areas to deposit eggs. The quality of the placed sand could affect the ability of female turtles to nest, the suitability of the nest incubation environment, and the ability of hatchlings to emerge from the nest. Potential beneficial effects include more stable nesting beaches which reduce the potential for erosion destroying nests, prevention of beaches from becoming littered with fallen trees and vegetative debris which may be a deterrent to nesting, and a decrease in the potential for erosion escarpment formation.

ENVIRONMENTAL BASELINE

Status of the Species within the Action Area

The distribution of sea turtle nesting activity on Florida's Gulf Coast (Sarasota, Charlotte, Lee, and Collier Counties) is understood less than that of the East Coast epicenter of sea turtle nesting between Brevard and Palm Beach Counties (Addison et al. 2000). Ten to twelve percent of the total nesting activity on Florida's beaches occurs on Florida's Gulf Coast (Addison et al. 2000). The mean number of nests recorded annually from 1994 to1999 in Collier County was 1,201. In 2000 there were a total of 1,361 nests recorded, 954 were recorded in 2001, 741 in 2001, and 1,147 for 2003 (FWC 2004). Only Sarasota County has more nests, with a mean of 3,491 nests or 41 percent of all Gulf Coast nests. Charlotte, Lee, and Collier Counties have 14, 8, and 15 percent, respectively, of the Gulf Coast nests for the period between 1994 and 1999.

Prior to 1994, no comparable data were available on the amount of nesting in Collier County, although Caretta Research, Incorporated conducted nesting surveys in Collier County during the 1960s and 1970s (LeBuff 1990). From the Lee County line to Cape Romano in Collier County, 36 miles of linear coastal barrier islands constitute potential sea turtle nesting habitat. Southeast of Cape Romano, the Ten Thousand Islands include numerous short beaches on Gulf-fronting islands that are used by nesting sea turtles (Addison et al. 2000).

A daily sea turtle activity survey of 22.1 miles (35.6 kilometers [km]) of beach was conducted by the CCNRD, The Conservancy of Southwest Florida, and Delnor-Wiggins Pass State Recreation Area personnel for sea turtle activities during the 2000 sea turtle season (May through October). A total of 552 sea turtle nests were located within the surveyed area, which included Barefoot, Vanderbilt, Park Shore, and Marco Island Beaches; Naples Beach; and the Delnor-Wiggins Pass State Recreation Area. The first adult sea turtle emergence was recorded on April 29, 2000, and the last on August 10, 2000. A total of 1,113 emergences (552 nests and 561 false crawls) were identified along the surveyed shoreline. Sea turtle weekly emergence (nests and false crawls) trends indicated peak sea turtle emergences between June 6 and July 7 for the 1999 and 2000 nesting seasons. For the 2000 nesting season, 2.7 percent (15) of the documented nests were disoriented (approximately 895 hatchlings), a decrease from 4.6 percent (27) disoriented nests in 1999. Storms inundated 25 percent of the nests (140) and 5 percent (27) of the nests were washed away. Fifteen percent (81) of the nests were predated, an increase from 12 percent (71) in 1999. Raccoons (*Procyon lotor*), gray foxes (*Urocyon cinereoargenteus*), fire ants (*Solenopsis invicta*), and unknown predators were the most prevalent predators of sea turtle eggs and hatchlings. A total of 38,391 hatchlings were estimated to have reached the Gulf of Mexico from the surveyed beaches.

The number of strandings in Collier County in 2000 (108) was significantly higher than the 28 strandings in 1999, representing a 415 percent increase from the past five-year average of 26 per year. Seventy-four loggerhead sea turtles, 29 Kemp's ridley sea turtles (*Lepidochelys kempi*), three green turtles, one hawksbill (*Eretmochelys imbricatai*), and one unidentified turtle were recorded as stranded on Collier beaches from January through December 2000 (CCNRD 2001). From January through late April, a widespread bloom of red tide (*Gymnodinium breve*) coincided with 46 of the 108 strandings, providing circumstantial evidence that sea turtle exposure to red tide can be linked to a possible cause of death (CCNRD 2001). The second peak of strandings occurred during the period of May through July, corresponding to sea turtle nesting season. Twenty-five of the 50 strandings were fresh to moderately decomposed large male loggerhead sea turtles, apparently healthy at the time of death, indicating possible interaction with fisheries (CCNRD 2001).

The Marco Island coastal barrier unit, which includes the 1.4-mile project area at Hideaway Beach, encompasses 5.6 miles (8.8 km) from inside Big Marco Pass (Hideaway Beach to Caxambas Pass). Marco Island has been monitored for sea turtle activities since 1990 as part of permit requirements for various beach renourishment and raking activities (CCNRD 2001).

Additional sea turtle activity surveys have been conducted by the Service, The Conservancy of Southwest Florida, and DEP on Key Island, Sea Oat and Coconut Islands, the Kice Island/Cape Romano Complex, and in the Ten Thousand Islands, including Ten Thousand Islands National Wildlife Refuge and state-designated aquatic preserve. Most surveys were conducted twice a week between May 1 and August 31, with the exception of Key Island, which was monitored daily between May 1 and August 31 (Addison et al. 2000). The Ten Thousand Islands area was first surveyed in 1991 and surveys were expanded from 6 to 11 islands in 1996.

In Collier County, for the period 1994 to 1999, there was more overall nesting activity on Barefoot, Vanderbilt, Park Shore, Marco Island, Naples, and Delnor-Wiggins Pass beaches (generally defined as urban), as well as the Key Island and Kice Island/Cape Romano beaches. However, the highest nesting densities occurred in the non-urban Ten Thousand Islands on Panther, Gullivan, and Kingston Keys with nest densities of 37, 38, and 54 nests/km (Addison et al. 2000). Although nesting densities are higher on these beaches, predation is also higher, and predator control measures have been initiated on some public lands. Twenty-two percent of all sea turtle nesting in Collier County occurs in the Ten Thousand Islands.

Loggerhead Sea Turtle

The loggerhead sea turtle nesting and hatching season for the southern Florida Gulf of Mexico beaches (Pinellas through Monroe Counties) extends from April 1 through November 30. Incubation ranges from about 45 to 95 days. The loggerhead sea turtle is the most abundant sea turtle species nesting in Collier County. The mean number of loggerhead sea turtles that nested in Collier County from 1994 to 1999 was 1,202 and ranged from 1,070 to 1,322 (Addison et al. 2000).

For the Marco Island beaches, between 1990 and 2000, sea turtle nests numbered from 33 to 91 and averaged 55.8 per year for the 11 years between 1990 to 2000. False crawls numbered from 38 to 165 and averaged 96 per year for the same time period (CCNRD 2001).

For the year 2000, 50 total nests, 52 false crawls, 102 emergences of adult turtles, and a nesting success of 49 percent were documented for the Marco Island beaches. For the year 2000, Marco Island had the least emergence activity (18/mile or 28.9/km), least nests (9/mile or 14.48/km), and the lowest number of false crawls per mile (9 or 14.48/km) of any of the surveyed beaches in the Collier County Study (CCNRD 2001).

The clutch size for Marco Island was 112 for the year 2000, higher than the average 102 for the other areas surveyed in the Collier County report. Overall hatch success was 73 percent of 4,819 eggs and overall emergence success was 71 percent. Seven of 50 nests were lost, primarily as a result of Hurricane Gordon on September 12, 2000, so some nests were not evaluated (CCNRD 2001).

Of the 15 hatchling disorientations documented in 2000 by the Collier County Study, 10 (66 percent) were located on Marco Island, resulting in an estimated 726 disoriented hatchlings. Beach lighting violations pursuant to the Collier County Sea Turtle Protection Regulations (Collier County Land Development Code Sec. 3.10, 1994) totaled 206, with 71 (34 percent) on Marco Island. Nest disorientation in Collier County has steadily decreased from 42 in 1996 to 15 in 2000 (CCNRD 2001). With the incorporation of Marco Island, sea turtle lighting violations are now handled by city ordinance. The Hideaway Beach development has been described as a model for other projects as a result of their cooperation in reducing or eliminating lighting effects on sea turtles (Maura Kraus, CCNRD, personal communication, 2000).

The application information provided by the CCNRD documents that sea turtle nesting increased from 1998 to 1999 in the overall vicinity of the Hideaway Beach area after temporary groin placement in 1997. Nesting within Collier County and on Marco Island also increased in 1998 and 1999. In 2000, sea turtle nesting on Hideaway Beach declined yet remained above the pre-groin annual average. It is not clear from the data whether these increases and decreases are related to other influences, groin construction, frequent sand nourishment, or the availability of the adjacent tidal shoals of the BMPCWA as attractants to sea turtles. Overall nests ranged from 1 to 13 annually on Hideaway Beach from 1990 to 1997, and ranged from 10 to 24 annually from 1998 to 2000. (Note: there were 31 nests in this area in 2001.) The location of the nests relative to the groin fields prior to groin construction indicates some preference in most years for areas which were not eroding. Since construction of the groins the eroding areas have been more stable, and nesting has now been documented in these areas as well.

For the year 2000, nine sea turtle nests and seven false crawls were documented for Hideaway Beach (project site) between DEP monuments H-1 and H-16. Monument H-1 is located between the two existing temporary groins at South Point, and monuments H-9 and H-10 are in the temporary groin field for the three existing temporary groins at Royal Marco Point. The proposed two additional temporary groins are located at Royal Marco Point near monument H-11 and at South Point, southwest of monument H-2. During the 2000 sea turtle nesting season, one sea turtle nest and one false crawl occurred at monument H-1 and two sea turtle nests were located in the vicinity of monument H-9. One sea turtle nest occurred at monument H-11.

Green Sea Turtle

The green sea turtle nesting and hatching season for the southern Florida Gulf of Mexico beaches extends from May 15 through October 31. Incubation ranges from about 45 to 75 days. Green sea turtle nesting has been reported/rumored in the southwest Florida region on a periodic basis. However, in 1994, nine green sea turtle nests were confirmed on Naples Beach, Key Island, and Turtle Key (north and south of the project area along the coast). These nests produced 236 hatchlings, although hatchling information was not available for all documented nests (Addison et al. 2000). While green sea turtle nesting has not been documented in the project area, the potential for nesting by this species exists in the project area.

Factors Affecting the Species Environment within the Action Area

A major beach nourishment (approximately 48 acres of sand) occurred on the Marco Island shoreline, north and south of the BMPCWA under Corps permit application number 88IPC-20290, which included a portion of the Hideaway Beach project, in 1990 and 1991. A segmented breakwater was also constructed on the south end of the island in 1996 to improve the stability of the shoreline adjacent to Caxambas Pass. The Service previously commented on the construction of five temporary groins at the project site in a letter dated December 23, 1996. Concerns as stated in that correspondence remain the same, and include the sensitivity of the project shoreline relative to proximity to the State-designated BMPCWA to the southwest, an important sea turtle nesting area. Other sensitive resources in the project area include Coconut Island, which is seaward of Hideaway Beach and is part of the state-designated Rookery Bay

Aquatic Preserve. The BMPCWA is a dynamic sandbar (Sand Dollar Island) that periodically advances landward and connects and enhances the Marco Island shoreline. This sandbar and surrounding beaches and intertidal areas provide habitat for shore and wading birds, including the federally threatened piping plover, as well as many State-listed species.

This project, as proposed, would install a permanent T-groin system and include a larger beach renourishment effort than the previously permitted project. The temporary groins will be removed as part of the new T-groin installation and renourishment effort. The temporary groins were constructed of large sand-filled bags which secured the shoreline in the immediate vicinity of the structures. Their stabilizing influence diminishes significantly with distance from the structures; however, monitoring has shown that the overall stability of the Hideaway Beach shoreline has improved since the structures were constructed. The net result of the temporary shoreline erosion control method appears to be partial protection in an area of rapidly eroding shoreline. The temporary groin fields were filled at construction in 1997. Since that time, renourishment was done east of the South Point groin field in 1998, 1999, and 2000; and within, as well as adjacent to, the Royal Marco Point groin field in 1998. No renourishment of the shoreline within the South Point groin field has been necessary. It is important to assess the direct and cumulative effects of the T-groin field on nearshore and intertidal habitat, as well as adjacent shoreline transport systems, to consider the project's beneficial effects on sea turtle nesting and to determine if the project has any negative impact on sea turtle nesting resources at and adjacent to the site.

EFFECTS OF THE ACTION

The Hideaway Beach project was designed to minimize impacts, and monitoring data has documented an increase in nesting density along the project beach since the temporary T-groins were constructed and maintained with periodic renourishment.

Factors to Be Considered

The proposed beach renourishment site and T-groin field are utilized by nesting (primarily loggerhead) sea turtles. Beaches adjacent to the project area have also been used by nesting turtles. Though disturbance is predicted to be annual, the history of the project indicates that nourishment and T-groin repair have occurred more frequently and could exceed this frequency if the dynamics of the surrounding shoreline change or if a major storm event or extended erosive event occurs. The project will affect shoreline that was the site of an average of 11.5 nests per year prior to construction of the T-groins in 1997 and 19.1 nests per year between 1997 and 2004. In the years following temporary T-groin construction, Hideaway Beach monitoring documented 29 nests in 1998, 27 nests in 1999, 9 nests in 2000, 29 nests in 2001, 4 nests in 2002, 12 nests in 2003, and 22 nests in 2004. In comparison, the number of nests documented prior to construction ranged between 1 and 24 for the years between 1990 and 1997. Detected nest numbers greater than 20 occurred once, in 1995. From these data, it appears that nesting effort has increased in the Hideaway Beach footprint since installation of the temporary T-groins. Since other measured parameters have not been compared for pre- and post-construction, a conclusion on the success of the T-groins cannot be made.

The construction time for the project is approximately 150 days; therefore, construction may encompass the entire 2005 sea turtle nesting season. Beyond short-term construction activities, the direct and indirect effects of the project on sea turtles and their nesting habitat will extend beyond the construction period. Construction is planned for daytime only; therefore, there should be no adverse effect of project-related lighting on sea turtles or hatchlings.

The proposed action has the potential to adversely affect nesting females, nests, and hatchlings within the proposed project area during the renourishment activities (short-term effects) and through the establishment of erosion control structures (long-term effects).

Analyses for Effects of the Action

Beneficial Effects

The placement of sand on a beach with reduced dry fore-dune habitat may increase sea turtle nesting habitat if the placed sand is compatible (*i.e.,* grain size, shape, color, etc.) with naturally occurring beach sediments in the area, and compaction and escarpment remediation measures are incorporated into the project. In addition, a nourished beach that is designed and constructed to mimic a natural beach system may be more stable than the eroding one it replaces, thereby benefiting sea turtles.

Erosion control structures constructed in appropriate high erosion areas, or to offset the effects of shoreline armoring, may benefit sea turtles in areas by reestablishing nesting habitat where none currently exists. However, caution should be exercised to avoid automatically assuming that reestablishing nesting habitat will wholly benefit sea turtle populations without determining the extent that emergent erosion control structures affect hatchling behavior.

Direct Effects

Placement of sand on a beach alone may not provide suitable nesting habitat for sea turtles. Although beach nourishment may increase the potential nesting area, significant negative effects to sea turtles may result if protective measures are not incorporated during project construction. Nourishment and erosion control structure construction during the nesting season, particularly on or near high density nesting beaches, can cause increased loss of eggs and hatchlings and, along with other mortality sources, may significantly impact the long-term survival of the species. For instance, projects conducted during the nesting and hatching season could result in the loss of sea turtles through disruption of adult nesting activity and by burial or crushing of nests or hatchlings. While a nest monitoring and relocation program or a nest mark and avoidance program would reduce these impacts, nests may be inadvertently missed (when crawls are obscured by rainfall, wind, and/or tides) or misidentified as false crawls during daily patrols. In addition, nests may be destroyed by operations at night prior to beach patrols being performed. Even under the best of conditions, about seven percent of the nests can be misidentified as false crawls by experienced sea turtle nest surveyors (Schroeder 1994).

Potential adverse effects during the project construction phase include disturbance of existing nests, which may have been missed, disturbance of females attempting to nest, and disorientation of emerging hatchlings. Heavy equipment will be required to install the T-groins and this equipment will have to traverse the beach to the project site, which could result in harm to nesting females, nests, and emerging hatchlings. Since a large trench will be excavated on the beach and be present during the night for some portion of the construction, a potential threat to nesting females and emerging hatchlings will exist.

Following construction, the presence of erosion control structures has the potential to adversely affect sea turtles. For instance, they may interfere with the egress and ingress of adult females at nesting sites; alter downdrift beach profiles through erosion, escarpment formation, and loss of berms; trap and/or obstruct hatchlings during a critical life-history stage; increase hatchling and adult female energy expenditure in attempts to overcome the structures; and attract additional predatory fish or concentrate existing predatory fish, thereby increasing in the potential of hatchling predation.

1. Nest relocation

Project construction, including both sand placement and T-groin construction, is likely to occur during the sea turtle nesting season, therefore, sea turtle nest relocation is a possibility during the estimated 5-month project construction window. Besides the potential for missing nests during a nest relocation program, there is a potential for eggs to be damaged by their movement, particularly if eggs are not relocated within 12 hours of deposition (Limpus et al. 1979). Nest relocation can have adverse impacts on incubation temperature (and hence sex ratios), gas exchange parameters, hydric environment of nests, hatching success, and hatchling emergence (Limpus et al. 1979; Ackerman 1980; Parmenter 1980; Spotila et al. 1983; McGehee 1990). Relocating nests into sands deficient in oxygen or moisture can result in mortality, morbidity, and reduced behavioral competence of hatchlings. Water availability is known to influence the incubation environment of the embryos and hatchlings of turtles with flexible-shelled eggs, which has been shown to affect nitrogen excretion (Packard et al. 1984), mobilization of calcium (Packard and Packard 1986), mobilization of yolk nutrients (Packard et al. 1985), hatchling size (Packard et al. 1981; McGehee 1990), energy reserves in the yolk at hatching (Packard et al. 1988), and locomotor ability of hatchlings (Miller et al. 1987).

In a 1994 Florida study comparing loggerhead hatchlings and emergence success of relocated nests with *in situ* nests, Moody (1998) found that hatchling success was lower in relocated nests at nine of the beaches evaluated. Emergence success was lower in relocated nests at 10 of the 12 beaches surveyed in 1993 and 1994.

2. Equipment

The placement of pipelines and erosion control structure construction materials, as well as the use of heavy machinery or equipment on the beach during a construction project, may also have adverse effects on sea turtles. They can create barriers to nesting females emerging from the surf and crawling up the beach, causing a higher incidence of false crawls and unnecessary energy expenditure. The equipment can also create impediments to hatchling sea turtles as they crawl to the ocean.

3. Artificial lighting

Visual cues are the primary sea-finding mechanism for hatchling sea turtles (Mrosovsky and Carr 1967; Mrosovsky and Shettleworth 1968; Dickerson and Nelson 1989; Witherington and Bjorndal 1991). When artificial lighting is present on or near the beach, it can misdirect hatchlings once they emerge from their nests and prevent them from reaching the ocean (Philbosian 1976; Mann 1977; FWC disorientation database). In addition, a significant reduction in sea turtle nesting activity has been documented on beaches illuminated with artificial lights (Witherington 1992). Therefore, construction lights along a project beach and on the dredging vessel may deter females from coming ashore to nest, misdirect females trying to return to the surf after a nesting event, and misdirect emergent hatchlings from adjacent non-project beaches. Any source of bright lighting can profoundly affect the orientation of hatchlings, both during the crawl from the beach to the ocean and once they begin swimming offshore. Hatchlings attracted to light sources on dredging barges may not only suffer from interference in migration, but may also experience higher probabilities of predation to predatory fishes that are also attracted to the barge lights. This impact could be reduced by using the minimum amount of light necessary (may require shielding) or low pressure sodium lighting during project construction.

Collier County (Maura Kraus, CCNRD, personal communication, 2004) provided nest and disorientation information for Hideaway Beach. In 1997, there were nine nests with no disorientations; 1998 saw 29 nests with two disorientations. In 1999, 27 nests were documented with no disorientations. In 2000, out of nine nests, two disorientations were documented. For the years 2001, 2002, and 2003; 29, 4, and 12 nests were documented, respectively, with no disorientations. In 2004, there were 22 nests and 1 disorientation. All disorientations were due to lighting in the vicinity, not to equipment. Marco Island has a lighting ordinance and appropriate actions were taken to address each disorientation noted.

4. Entrapment/physical obstruction

The erosion control structures proposed for Hideaway Beach include the construction of 10 T-groins. Although designed to be submerged much of the time, these structures have the potential to interfere with the egress and/or ingress of adult females at nesting sites where they may proceed around them successfully, abort nesting for that night, or move to another section of beach to nest. This may cause an increase in energy expenditure, and, if the body of the T-groin is exposed, may act as barrier between beach segments and also prevent nesting on the T-groin alignment.

T-groins constructed in Palm Beach County, Florida were observed to serve as impediments to the offshore migration by hatchlings. Howard and Davis (1999) found that 13 percent of hatchlings emerging from nests laid near T-groins encountered the T-groins on their trek to the ocean. However in this case, the project design for sand placement around the T-groins was not properly followed. The project was designed to have a narrower fill section in the vicinity of the

T-groins so the shore parallel T-heads would be seaward of the high water line and hatchlings would be able to swim over them. The T-groin section received more fill than expected which caused the high water line to be further seaward than expected. As a result, hatchlings were trapped in the corner of the structure at the head and body joint intersection. This was attributed to the exposure of the T-head and body above the high water line and the presence of artificial lighting in the vicinity of the T-groins which caused the hatchlings to disorient in the direction of the T-groins.

In contrast, the T-groins proposed for Hideaway Beach are designed with a weir in the center of the T-head and at the point where the body joins the head to allow wave energy to pass behind the T-head and facilitate littoral transport of material downdrift of the structures. Despite these measures, it is reasonable to hypothesize that the emergent, shore-parallel structures may obstruct sea turtle hatchlings.

Currently, there are few erosion control structures with similar designs as those proposed that exist along Florida's west coast. Those that do exist include the current temporary T-groins constructed on Hideaway Beach, Marco Island, Collier County; North Captiva Island, Lee County; and South Naples Beach, Collier County in 1997, 1998, and 2000, respectively. Although limited nesting has occurred near the existing T-groin structures and performance results are encouraging, monitoring has not been implemented to evaluate the effects of the structures on sea turtles, particularly in relation to the offshore migration of hatchlings.

Typically, sea turtles emerge from the nest at night when lower sand temperatures elicit an increase in hatchling activity. After emergence, approximately 20 to 120 hatchlings crawl *en masse* immediately to the surf using predominately visual cues to orient themselves (Witherington and Salmon 1992). Upon reaching the water, loggerhead and green turtle hatchlings orient themselves into the waves and begin a period of hyperactive swimming activity, or swim frenzy, which lasts for approximately 24 hours (Witherington 1991; Wyneken et al. 1990; Salmon and Wyneken 1987). The swim frenzy effectively moves the hatchling quickly away from shallow, predator rich, nearshore waters to the relative safety of deeper water (Gyuris 1994; Wyneken et al. 2000.)

The first hour of a hatchling's life is precarious and predation is high, but threats decrease as hatchlings distance themselves from the natal beach (Stancyk 1995; Pilcher et al. 2000). Delays in hatchling migration (both on the beach and in the water) can cause added expenditures of energy and an increase of time spent in predator rich nearshore waters.

Rarely will hatchlings encounter natural nearshore features that are similar to the emergent shore-parallel structures proposed for this project. However, observations of hatchling behavior during an encounter with a sand bar at low tide, a natural shore-parallel barrier, showed the hatchlings maintained their shore-perpendicular path seaward, by crawling over the sand bar versus deviating from this path to swim parallel around the sand bar through the trough, an easier alternative. Therefore, the T-groins may adversely affect sea turtle hatchlings by serving as a barrier or obstruction to sea turtle hatchlings delaying offshore migration; depleting or increasing expenditure of the "swim frenzy" energy critical to reach the relative safety of offshore development areas; and possibly entrapping hatchlings within the crevices of the structures or within eddies or other associated currents.

5. Missed nests

Although a nesting survey and nest marking program would reduce the potential for nests to be impacted by construction activities, nests may be inadvertently missed (when crawls are obscured by rainfall, wind, and/or tides) or misidentified as false crawls during daily patrols. Even under the best of conditions, about seven percent of the nests can be misidentified as false crawls by experienced sea turtle nest surveyors (Schroeder 1994).

6. Predator concentration

The presence of T-groins has the potential to attract and concentrate predatory fishes and provide perching spots for predatory birds, resulting in higher probabilities of hatchling predation as hatchlings enter the ocean and attempt to reach offshore habitat. The natural bottom habitat adjacent to Hideaway Beach is described as steeply sloping with no seagrasses or hardbottom communities. The introduction of high relief structures such as the T-groins are likely to attract and concentrate predatory fish to this area where similar habitat is not naturally present and the numbers of predatory fish, such as tarpon, are currently high. In addition, colonization of the structures by epibenthic macroalgae, invertebrates, and other organisms will change over time and will likely result in changes of fish assemblages as the structures mature and continue to concentrate predators in the future.

It is known that hatchling predation in nearshore waters is high (Gyuris 1994; Wyneken and Salmon 1996). There are many documented occurrences of nearshore predators captured with hatchlings found in their digestive tracts. During hatchling predation studies in Broward County, Florida, it was documented that predatory fish species, such as tarpon and snappers (*Lutjanus* spp.), targeted sea turtle hatchlings and "learned" where to concentrate foraging efforts (Wyneken et al. 1998). Therefore, a delay in the offshore migration can cause increased predation of sea turtle hatchlings (Glenn 1998; Gyuris 1994; Witherington and Salmon 1992).

Indirect Effects

Many of the direct effects of beach nourishment and T-groin construction may persist over time and become indirect effects. These indirect effects include increased susceptibility of relocated nests to catastrophic events, the consequences of potential increased beachfront development, changes in the physical characteristics of the beach, the formation of escarpments, future sand migration, increased erosion downdrift of the erosion control structures, impacts of debris on the beach from erosion control structure breakdown, and increased erosion of shorelines adjacent to borrow site as a result of ebb shoal excavation.

1. Increased susceptibility to catastrophic events

Nest relocation may concentrate eggs in an area making them more susceptible to catastrophic events. Hatchlings released from concentrated areas also may be subject to greater predation rates from both land and marine predators, because the predators learn where to concentrate their efforts (Glenn 1998; Wyneken et al. 1998).

2. Increased beachfront development

Pilkey and Dixon (1996) state that beach replenishment frequently leads to more development in greater density within shorefront communities that are then left with a future of further replenishment or more drastic stabilization measures. Dean (1999) also notes that the very existence of a beach nourishment project can encourage more development in coastal areas. Following completion of a beach nourishment project in Miami during 1982, investment in new and updated facilities substantially increased tourism there (National Research Council 1995). Increased building density immediately adjacent to the beach often resulted as older buildings were replaced by much larger ones that accommodated more beach users. Overall, shoreline management creates an upward spiral of initial protective measures resulting in more expensive development which leads to the need for more and larger protective measures. Increased shoreline development may adversely affect sea turtle nesting success. Greater development may support larger populations of mammalian predators, such as foxes and raccoons, than undeveloped areas (National Research Council 1990), and can also result in greater adverse effects due to artificial lighting, as discussed above.

3. Changes in the physical environment

Beach nourishment may result in changes in sand density or compaction, beach shear resistance or hardness, beach moisture content, beach slope, sand color, sand grain size, sand grain shape, and sand grain mineral content if the placed sand is dissimilar from the original beach sand (Nelson and Dickerson 1988a). These changes could result in adverse impacts on nest site selection, digging behavior, clutch viability, and emergence by hatchlings (Nelson and Dickerson 1987; Nelson 1988).

Beach compaction and unnatural beach profiles that may result from beach nourishment activities could negatively impact sea turtles, regardless of the timing of projects. Very fine sand and/or the use of heavy machinery can cause sand compaction on nourished beaches (Nelson et al. 1987; Nelson and Dickerson 1988a). Significant reductions in nesting success (*i.e.,* false crawls occurred more frequently) have been documented on severely compacted nourished beaches (Fletemeyer 1980; Raymond 1984; Nelson and Dickerson 1987; Nelson et al. 1987), and increased false crawls may result in increased physiological stress to nesting females. Sand compaction may increase the length of time required for female sea turtles to excavate nests and also cause increased physiological stress to the animals (Nelson and Dickerson 1988b). Nelson and Dickerson (1988c) concluded that, in general, beaches nourished from offshore borrow sites are harder than natural beaches, and while some may soften over time through erosion and accretion of sand, others may remain hard for 10 years or more.

These impacts can be minimized by using suitable sand and by tilling compacted sand after project completion. The level of compaction of a beach can be assessed by measuring sand compaction using a cone penetrometer (Nelson 1987). Tilling of a nourished beach with a root rake may reduce the sand compaction to levels comparable to unnourished beaches. However, a pilot study by Nelson and Dickerson (1988b) showed that a tilled nourished beach will remain uncompacted for up to 1 year. Therefore, the Service requires multi-year beach compaction monitoring and, if necessary, tilling to ensure that project impacts on sea turtles are minimized.

A change in sediment color on a beach could change the natural incubation temperatures of nests in an area, which, in turn, could alter natural sex ratios. To provide the most suitable sediment for nesting sea turtles, the color of the nourished sediments must resemble the natural beach sand in the area. Natural reworking of sediments and bleaching from exposure to the sun would help to lighten dark nourishment sediments; however, the time-frame for sediment mixing and bleaching to occur could be critical to a successful sea turtle nesting season.

For the proposed Hideaway Beach project, a compatibility analysis of the native beach sediment and the sediment at the proposed borrow area was conducted. A composite grain size distribution curve of each sediment core was compared to the composite grain size distribution curve of the existing beach sediment. Frequency distribution curves of the composite grain size distribution of each sediment core were compared to the frequency distribution curve of the composite grain size distribution of the existing beach. The material from the borrow area is natural littoral material from the general project vicinity. The borrow area contains slightly higher shell fractions than the 1995 native beach. The shell fraction of the borrow material is relatively fine, and the grain size distribution of the borrow material was found to be slightly finer than the native material. The borrow material is clean with the silt content of composite samples ranging from 1.6 percent to 4.0 percent. The material is considered to be compatible for beach fill, with a low overfill ratio of 1.13. Based upon the information and analysis provided by the applicant, the beach fill material to be excavated from the proposed borrow area is expected to maintain the general character and functionality of the material occurring on the beach and in the adjacent dune and coastal system (DEP 2001).

4. Escarpment formation

On nourished beaches, steep escarpments may develop along the water line interface as the beach adjusts from an unnatural construction profile to a more natural beach profile (Coastal Engineering Research Center 1984; Nelson et al. 1987). In addition, escarpments may develop on the crenulate beaches located between T-groins as the beaches equilibrate to their final positions. These escarpments can hamper or prevent access to nesting sites (Nelson and Blihovde 1998). Researchers have shown that female turtles coming ashore to nest can be discouraged by the formation of an escarpment, leading to situations where they choose marginal or unsuitable nesting areas to deposit eggs (*e.g.,* in front of the escarpments, which often results in failure of nests due to prolonged tidal inundation). This impact can be minimized by leveling any escarpments prior to the nesting season.

The T-groin design proposed for Hideaway Beach is a refinement of three recently constructed T-groin projects on Florida's west coast as follows: experimental T-groins were constructed using geotextile bags on Hideaway Beach, Marco Island, Collier County; rock T-groins were constructed on the Kohler property, North Captiva Island, Lee County; and modified rock T-groins were constructed on South Naples Beach, Collier County in 1997, 1998, and 2000, respectively. Monitoring results of the three projects has shown that the performance of the proposed design is significantly different from conventional terminal groin and T-groin designs, including the T-groins constructed in Palm Beach County (Humiston 2001), as described in the preceding "Direct Effects" section of this document.

All three projects using the proposed design demonstrate that this design may minimize erosion escarpments within the groin field, and may reduce escarpment formation on adjacent beaches. Monitoring data show that previously high downdrift erosion rates have been reduced (Humiston and Moore Engineers 2000a; Humiston and Moore Engineers 2001a; Humiston and Moore Engineers 2001b). For instance, downdrift erosion on North Captiva Island was reduced from an average of approximately 20 feet per year during the year of T-groin construction, to approximately five feet per year, three years later. Though preconstruction survey data from the downdrift shoreline on North Captiva Island do not exist, analysis of historical aerial photographs indicated pre-groin erosion rates of approximately 30 feet per year (Humiston and Moore Engineers 2000b).

5. Downdrift erosion related to erosion control structures

Erosion control structures (*e.g.,* terminal groins, T-groins, and breakwaters), in conjunction with beach nourishment, can help stabilize U.S. East Coast barrier island beaches (Leonard et al. 1990). However, groins and breakwaters often result in accelerated beach erosion downdrift of the structures (Komar 1983; National Research Council 1987; Corps 1992) and corresponding degradation of suitable sea turtle nesting habitat (NOAA Fisheries and Service 1991a, 1991b, 1992). Impacts first are noted and greatest changes are observed close to the structures, but effects eventually may extend great distances along the coast (Komar 1983). Beach nourishment only partly alleviates impacts of groin construction on downdrift beaches (Komar 1983).

Terminal groins operate by blocking the natural littoral drift of sand (Kaufman and Pilkey 1979; Komar 1983). Once sand fills the updrift groin area, some littoral drift and sand deposition on adjacent downdrift beaches occurs due to spillover. But, groins often force the river of sand into deeper offshore water, and sand that previously would have been deposited on downdrift beaches is lost from the system (Kaufman and Pilkey 1979). Conventional terminal rubble mound groins control erosion by trapping sand and dissipating some wave energy. In general, terminal groins are not considered a favorable erosion control alternative because they usually impart stability to the updrift beach and transfer erosion to the downdrift side of the structure. Additionally, they deflect longshore currents offshore, and excess sand built up on the updrift side of the structure may be carried offshore by those currents. This aggravates downdrift erosion and erosion escarpments are common on the downdrift side of terminal groins (Humiston 2001).

Likewise, conventional T-groins function in a manner similar to a regular conventional groin, except that the shore parallel section adds a breakwater-like feature which dissipates more wave energy than a shore-perpendicular groin. A conventional T-groin consists of a terminal groin with a shore parallel section connected to the seaward end. However, the conventional T-groin may also act as a barrier to littoral transport and result in adverse downdrift impacts (Humiston 2001).

Unlike conventional T-groins, the T-groins proposed for the Hideaway Beach project were designed specifically to minimize potential adverse effects downdrift of the structures. For instance, they have a low profile trunk section which is below mean low water (MLW) behind the T-section. This allows longshore current and sand transport to continue landward of the T-section. In addition, the T-head portion of the groin has low profile and a weir or gap in the center to allow the passage of wave energy to improve sand bypassing behind the structure (Humiston 2001).

6. Erosion control structure breakdown

If the structures fail and break apart, debris may spread upon the beach, which may further impede nesting females from accessing suitable nesting sites (resulting in a higher incidence of false crawls) and trap hatchlings and nesting turtles (NOAA Fisheries and Service 1991a, 1991b).

7. Erosion as a result of nearshore dredging activities

Future sand displacement on nesting beaches is a potential adverse effect of the nourishment project. Dredging of sand nearshore of the project area has the potential to cause erosion of the newly created beach or other areas on the same adjacent beaches by creating a sand sink. The remainder of the system responds to this sand sink by providing sand from adjacent beaches in an attempt to reestablish equilibrium (National Research Council 1990).

The natural littoral borrow material will be obtained from the Big Marco Pass shoal in the general project vicinity. To verify compatibility with native beach sand, analysis was completed comparing the borrow area grain size distributions to the native beach sand. Fifteen vibracores were collected to sample the material in the borrow area. Because the beach has been nourished and renourished a number of times, this comparison used the results of grain size information collected from the native beach in 1995, prior to renourishment with sand trucked from upland borrow areas and construction of the temporary T-groins. Since 1995, sand has been trucked to the beach from upland sources, including a source that washes and grades quartz sand which contains little to no shell. Shell content of beach samples collected at this time would therefore probably not accurately represent the original native beach. The borrow area contains slightly higher shell fractions than the 1995 native beach samples. The shell fraction of the borrow material is relatively fine and the grain size distribution of the borrow material was found to be slightly finer than the native material. The silt content ranges from 1.6 to 4.0 percent. The material is considered to be beach compatible, with a low overfill ratio of 1.13.

Species Response to the Proposed Action

Ernest and Martin (1999) conducted a comprehensive study to assess the effects of beach nourishment on loggerhead sea turtle nesting and reproductive success. The following findings illustrate sea turtle responses to and recovery from a nourishment project. A larger proportion of turtles emerging on nourished beaches abandoned their nesting attempts than turtles emerging on control or pre-nourished beaches. This reduction in nesting success was most pronounced during the first year following project construction and is most likely the result of changes in physical beach characteristics associated with the nourishment project (*e.g.,* beach profile, sediment grain size, beach compaction, frequency and extent of escarpments). During the first post-construction year, the time required for turtles to excavate an egg chamber on the untilled, hard-packed sands of one treatment area increased significantly relative to control and background conditions. However, in another treatment area, tilling was effective in reducing sediment compaction to levels that did not significantly prolong digging times. As natural processes reduced compaction levels on nourished beaches during the second post-construction year, digging times returned to background levels.

During the first post-construction year, nests on the nourished beaches were deposited significantly farther from both the toe of the dune and the tide line than nests on control beaches. Furthermore, nests were distributed throughout all available habitat and were not clustered near the dune as they were in the control. As the width of nourished beaches decreased during the second year, among-treatment differences in nest placement diminished. More nests were washed out on the wide, flat beaches of the nourished treatments than on the narrower steeply sloped beaches of the control. This phenomenon persisted through the second post-construction year monitoring and resulted from the placement of nests near the seaward edge of the beach berm where dramatic profile changes, caused by erosion and scarping, occurred as the beach equilibrated to a more natural contour.

Ernest and Martin (1999) found that the principal effect of nourishment on sea turtle reproduction was a reduction in nesting success during the first year following project construction. Although most studies have attributed this phenomenon to an increase in beach compaction and escarpment formation, Ernest and Martin indicated that changes in beach profile may have been more important. Regardless, as a nourished beach is reworked by natural processes in subsequent years and adjusts from an unnatural construction profile to a more natural beach profile, beach compaction and the frequency of escarpment formation decline, and nesting and nesting success return to levels found on natural beaches.

Similar short-term effects to listed sea turtle species and their habitat are anticipated to occur as a result of construction activities related to the proposed project. Generally, these adverse effects are limited to the first year after construction. The Service believes there is a potential for long-term adverse effects on sea turtle hatchlings as a result of the introduction of the permanent shore-parallel, erosion control structures. However, the Service acknowledges the potential benefits of the erosion control structures since they may minimize the effects of erosion on sea turtle nesting habitat, provide habitat seaward of shoreline stabilization structures within the project area, and extend the renourishment interval. Nonetheless, an increase in beach may not necessarily equate to an increase in suitable sea turtle nesting habitat.

CUMULATIVE EFFECTS

Cumulative effects include the effects of future State, tribal, local, or private actions that are reasonably certain to occur in the action area considered in this biological opinion. Future Federal actions that are unrelated to the proposed action are not considered in this section because they require separate consultation pursuant to section 7 of the ESA. The Service is not aware of any cumulative effects in the action area.

CONCLUSION

After reviewing the current status of the loggerhead and green sea turtle, the environmental baseline for the action area, the effects of the proposed beach nourishment, T-groin construction, dredging project, and the cumulative effects, it is the Service's biological opinion that the project, as proposed, is not likely to jeopardize the continued existence of the loggerhead and green sea turtle. No critical habitat has been designated for the loggerhead and green sea turtle in the continental U.S.; therefore, none will be affected.

The proposed project will affect approximately 1.4 miles of the approximately 1,400 miles of available sea turtle nesting habitat in the southeastern U.S. Research has shown that, in general, the principal effect of beach nourishment on sea turtle reproduction is a reduction in nesting success, and this reduction is most often limited to the first year following project construction. Research has also shown that the impacts of a nourishment project on sea turtle nesting habitat are typically short-term because a nourished beach will be reworked by natural processes in subsequent years, and beach compaction and the frequency of escarpment formation will decline. Although a variety of factors, including some that cannot be controlled, can influence how a nourishment and T-groin construction project will perform from an engineering perspective, measures can be implemented to minimize impacts to sea turtles. The Hideaway Beach project was designed to minimize impacts, and monitoring data has documented an increase in nesting density along the project beach since the temporary T-groins were constructed and maintained with periodic renourishment.

INCIDENTAL TAKE STATEMENT

Section 9 of the ESA and Federal regulation pursuant to section 4(d) of the ESA prohibit the take of endangered or threatened species, respectively, without special exemption. Take is defined as to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or to attempt to engage in any such conduct. Harm is further defined by the Service to include significant habitat modification or degradation that results in death or injury to listed species by significantly impairing essential behavioral patterns, including breeding, feeding, or sheltering. Harass is defined by the Service as intentional or negligent actions that create the likelihood of injury to listed species to such an extent as to significantly disrupt normal behavior patterns which include, but are not limited to, breeding, feeding, or sheltering. Incidental take is defined as take that is incidental to, and not the purpose of, carrying out an otherwise lawful activity. Under the terms of section 7(b)(4) and section 7(o)(2), taking that is incidental to and not intended as part of the agency action is not considered to be prohibited under the ESA provided that such taking is in compliance with the terms and conditions of this incidental take statement.

The measures described below are non-discretionary and must be implemented by the Corps so that they become binding conditions of any grant or permit issued to the applicant, as appropriate, for the exemption in section 7(o)(2) to apply. The Corps has a continuing duty to regulate the activity covered by this incidental take statement. If the Corps (1) fails to assume and implement the terms and conditions or (2) fails to require the applicant to adhere to the terms and conditions of the incidental take statement through enforceable terms that are added to the permit or grant document, the protective coverage of section 7(o)(2) may lapse. In order to monitor the impact of incidental take, the Corps must report the progress of the action and its impacts on the species to the Service as specified in the incidental take statement [50 CFR §402.14(i)(3)].

AMOUNT OR EXTENT OF TAKE

The Service anticipates nests and hatchlings associated with the approximately 1.4 miles of beach proposed for nourishment and T-groin construction could be taken as a result of this proposed action. The take is expected to be in the form of: (1) destruction of all nests that may be constructed and eggs that may be deposited and missed by a nest survey and egg relocation program within the boundaries of the proposed project; (2) destruction of all nests deposited during the period when a nest survey and egg relocation program is not required to be in place within the boundaries of the proposed project; (3) harassment in the form of disturbing or interfering with female turtles attempting to nest within the beach nourishment and T-groin construction area or on adjacent beaches as a result of construction activities; (4) reduced hatching success due to egg mortality during relocation and adverse conditions at the relocation site; (5) behavior modification of nesting females or hatchlings due to the presence of T-groins which may act as barriers to movement or cause misdirection; (6) behavior modification of nesting females if they dig into shallowly buried T-groins, resulting in false crawls or situations where they choose marginal or unsuitable nesting areas to deposit eggs; (7) behavior modification of nesting females due to escarpment formation resulting from readjustment of renourishment fill profiles within the project area during a nesting season, resulting in false crawls or situations where they choose marginal or unsuitable nesting areas to deposit eggs; and (8) destruction of nests from escarpment leveling within a nesting season when such leveling is made necessary due to readjustment of renourishment fill profiles and has been approved by the Service.

Incidental take is anticipated for only 1.4 miles of beach that have been identified for sand placement and T-groin construction. The Service anticipates incidental take of sea turtles will be difficult to detect for the following reasons: (1) turtles nest primarily at night and all nests are not found because [a] natural factors, such as rainfall, wind, and tides may obscure crawls and [b] human-caused factors, such as pedestrian and vehicular traffic, may obscure crawls and result in nests being destroyed because they were missed during a nesting survey and egg relocation program; (2) the total number of hatchlings per undiscovered nest is unknown; (3) the reduction in percent hatching and emerging success per relocated nest over the natural nest site is unknown; (4) an unknown number of females may avoid the project beach and be forced to nest in a less than optimal area; (5) lights may disorient an unknown number of hatchlings and cause death; and (6) escarpments may form during the readjustment of the beach profile after renourishment and cause an unknown number of females from accessing a suitable nesting site.

However, the level of take of these species can be anticipated by the disturbance of, renourishment of, and T-groin construction within suitable turtle nesting beach habitat and because: (1) turtles nest within the project site; (2) beach renourishment and T-groin construction will likely occur during a portion of the nesting season; (3) the renourishment project will modify the incubation substrate, beach slope, and sand compaction; (4) the T-groin construction project will modify beach profile and width; and (5) artificial lighting will disorient nesting females and hatchlings.

EFFECT OF THE TAKE

In the accompanying biological opinion, the Service determined that this level of anticipated take is not likely to result in jeopardy to the species. Critical habitat has not been designated in the project area; therefore, the project will not result in destruction or adverse modification of critical habitat.

REASONABLE AND PRUDENT MEASURES

The Service believes the following reasonable and prudent measures are necessary and appropriate to minimize take of loggerhead and green sea turtles:

1. Beach quality sand suitable for sea turtle nesting, successful incubation, and hatchling emergence must be used on the project site;

2. If the beach nourishment, T-groin construction, and dredging project will be conducted during the sea turtle nesting season, surveys for nesting sea turtles must be conducted. If nests are constructed in the area of beach nourishment, the eggs must be relocated;

3. Immediately after completion of the beach nourishment, T-groin construction, and dredging project, and prior to the next three nesting seasons, beach compaction must be monitored and tilling must be conducted as required to reduce the likelihood of impacting sea turtle nesting and hatching activities;

4. Immediately after completion of the beach nourishment and T-groin construction project, and prior to the next three nesting seasons, monitoring must be conducted to determine if escarpments are present and escarpments must be leveled as required to reduce the likelihood of impacting sea turtle nesting and hatching activities;

5. The applicant must ensure that contractors doing the beach nourishment, T-groin construction, and dredging work fully understand the sea turtle protection measures detailed in this incidental take statement;

6. During the sea turtle nesting season, construction equipment, pipes, and other materials must be stored in a manner that will minimize impacts to sea turtles to the maximum extent practicable;

7. During the sea turtle nesting season, lighting associated with the project must be minimized to reduce the possibility of disrupting and disorienting nesting and/or hatchling sea turtles; and

8. Maintenance nourishment should be strictly enforced to limit the exposure of the T-groin field and decrease risks for sea turtle hatchling entrapment.

TERMS AND CONDITIONS

In order to be exempt from the prohibitions of section 9 of the Act, the Corps must comply with the following terms and conditions, which implement the reasonable and prudent measures described above and outline required reporting/monitoring requirements. These terms and conditions are non-discretionary:

1. All fill material placed shall be sand that is similar to that already existing at the beach site in both coloration and grain size distribution. All such fill material shall be free of construction debris, rocks, or other foreign matter and shall generally not contain, on average, greater than 10 percent fines (*i.e.,* silt and clay) (passing the #200 sieve) and shall not contain, on average, greater than 5 percent coarse gravel or cobbles, exclusive of shell material (retained by the #4 sieve);

2. Daily early morning surveys for sea turtle nests shall be required if any portion of the beach nourishment, T-groin construction, and dredging project occurs during the period from April 1 through November 30. Nesting surveys must be initiated 65 days prior to nourishment activities or by April 1, whichever is later. Nesting surveys must continue through the end of the project or through November 30, whichever is earlier. If nests are constructed in areas where they may be directly affected by construction activities, such as renourishment, eggs shall be relocated per the following requirements:

    2a. Nesting surveys and egg relocations will only be conducted by personnel with prior experience and training in nest survey and egg relocation procedures. Surveyors must have a valid FWC permit. Nesting surveys will be conducted daily between sunrise and 9:00 a.m. Surveys will be performed in such a manner so as to ensure that construction activity does not occur in any location prior to completion of the necessary sea turtle protection measures;

2b. Only those nests that may be affected by direct construction activities (such as renourishment) must be relocated. Nests requiring relocation must be moved no later than 9 a.m. the morning following deposition to a nearby self-release beach site in a secure setting where artificial lighting will not interfere with hatchling orientation. Nest relocations in association with construction activities must cease when construction activities no longer threaten nests. Nests deposited within areas where construction activities have ceased or will not occur for 65 days shall be marked and left in place unless other factors threaten the success of the nest (nest laid below debris line marking the typical high tide, or nest laid in erosive areas). Any nests left in the active construction zone must be clearly marked. A circle with a radius of 10 feet, centered at the clutch (or the center of the disturbed area if the eggs cannot be located), will be marked by stake and survey tape or string. No construction activities will enter this circle and no adjacent construction will be allowed which might directly or indirectly disturb the area within the staked circle; and

2c. Daily sea turtle activity surveys must include all T-groins structures, effective on the first anticipated sea turtle hatching date for the year until November 30 or until all hatching activities have ceased at the project site. Any disoriented hatchlings that are associated with the T-groin structures will be immediately reported to the Corps and the South Florida Ecological Services Office of the Service so that remedial actions can be taken to avoid further effects;

3. Immediately after completion of the beach nourishment project and prior to April 1, for 3 subsequent years, sand compaction will be monitored in the area of restoration in accordance with a protocol agreed to by the Service, the State regulatory agency, and the applicant. At a minimum, the protocol provided under 3a and 3b below must be followed. If required, the area will be tilled to a depth of 36 inches and each pass of the tilling equipment must be overlapped to allow more thorough and even tilling. All tilling activity must be completed prior to April. If the project is completed during the nesting season, tilling will not be performed in areas where nests have been left in place or relocated.

   A report on the results of compaction monitoring must be submitted to the Service prior to any tilling actions being taken. An annual summary of compaction surveys and the actions taken must be submitted to the Service. This condition will be evaluated annually and may be modified if necessary to address sand compaction problems identified during the previous year. (NOTE: The requirement for compaction monitoring can be eliminated if the decision is made to till regardless of post-construction compaction levels. Also, out-year compaction monitoring and remediation are not required if placed material no longer remains on the beach.):

3a. Compaction sampling stations must be located at 500-foot intervals along the project area. One station will be at the seaward edge of the dune/bulkhead line (when material is placed in this area), and one station will be midway between the dune line and the high water line (normal wrack line).

At each station, the cone penetrometer will be pushed to a depth of 6, 12, and 18 inches three times (three replicates). Material may be removed from the hole if necessary to ensure accurate readings of successive levels of sediment. The penetrometer may need to be reset between pushes, especially if sediment layering exists. Layers of highly compact material may lay over less compact layers. Replicates shall be located as close to each other as possible, without interacting with the previous hole and/or disturbed sediments. The three replicate compaction values for each depth will be averaged to produce final values for each depth at each station. Reports will include all 18 values for each transect line, and the final 9 averaged compaction values; and

3b. If the average value for any depth exceeds 500 pounds per square inch (psi) for any two or more adjacent stations, then that area must be tilled immediately prior to April 1. If values exceeding 500 psi are distributed throughout the project area, but in no case do those values exist at two adjacent stations at the same depth, then consultation with the Service shall be required to determine if tilling is required. If a few values exceeding 500 psi are present randomly within the project area, tilling will not be required;

4. Visual surveys for escarpments along the project area shall be made immediately after completion of the beach nourishment and T-groin project and prior to April 1 for 3 subsequent years. Results of the surveys shall be submitted to the Service prior to any action being taken. Escarpments that interfere with sea turtle nesting or that exceed 18 inches in height for a distance of 100 feet shall be leveled to the natural beach contour by April 1. If the project is completed during the sea turtle nesting and hatching season, escarpments may be required to be leveled immediately, while protecting nests that have been relocated or left in place. The Service must be contacted immediately if subsequent reformation of escarpments that interfere with sea turtle nesting or that exceed 18 inches in height for a distance of 100 feet occurs during the nesting and hatching season to determine the appropriate action to be taken. If it is determined that escarpment leveling is required during the nesting or hatching season, the Service will provide a brief written authorization that describes methods to be used to reduce the likelihood of impacting existing nests. An annual summary of escarpment surveys and actions taken shall be submitted to the Service;

5. The applicant shall arrange a meeting between representatives of the contractor, the Service, the FWC, and the permitted person responsible for egg relocation within 30 days prior to the commencement of work on this project. At least 10 days advance notice shall be provided prior to conducting this meeting. This will provide an opportunity for explanation and/or clarification of the sea turtle protection measures;

6. From April 1 through November 30, staging areas for construction equipment and temporary storage of construction equipment must be located off the beach. Nighttime storage of construction equipment must be off the beach to minimize disturbance to sea turtle nesting and hatching activities. In addition, all construction pipes that are placed on the beach will be located as far landward as possible without compromising the integrity of

the existing or reconstructed dune system. Temporary storage of pipes must be off the beach to the maximum extent possible. Temporary storage of pipes on the beach will be in such a manner so as to impact the least amount of nesting habitat and must, likewise, not compromise the integrity of the dune systems (placement of pipes perpendicular to the shoreline is recommended as the method of storage);

7. From April 1 through November 30, direct lighting of the beach and near shore waters must be limited to the immediate construction area and must comply with safety requirements. Lighting on offshore or onshore equipment must be minimized through reduction, shielding, lowering, and appropriate placement to avoid excessive illumination of the waters surface and nesting beach while meeting all U.S. Coast Guard, EM 385-1-1, and Occupational Safety and Health Administration (OSHA) requirements. Light intensity of lighting plants must be reduced to the minimum standard required by OSHA for general construction areas, in order not to misdirect sea turtles. Shields must be affixed to the light housing and be large enough to block light from all lamps from being transmitted outside the construction area (Figure 3, on the following page);

8. In the event a sea turtle nest is excavated during construction activities, the permitted person responsible for egg relocation for the project should be notified so the eggs can be reburied or moved to a suitable relocation site;

9. Upon locating a sea turtle adult, hatchling, or egg harmed or destroyed as a direct or indirect result of the project, initial notification must be made to the South Florida Ecological Services Office, Vero Beach, at 772-562-3909. Care should be taken in handling injured turtles or eggs to ensure effective treatment or disposition, and in handling dead specimens to preserve biological materials in the best possible state for later analysis;

10. From April 1 to November 30, T-groin construction activities must be conducted during daylight hours only to avoid encountering nesting females and emerging hatchling sea turtles. Construction activities must not occur in any location prior to completion of the necessary sea turtle protection measures outlined below;

11. To the maximum extent practicable, all excavations and temporary alteration of beach topography resulting from T-groin construction will be filled or leveled to the natural beach profile prior to 9:00 p.m. each day. During any periods when excavated trenches must remain on the beach at night, nighttime sea turtle monitoring by the sea turtle permit holder will be required in the project area in order to further reduce possible impacts to nesting and hatchling sea turtles. Nighttime monitors will record data on false crawls, successful nesting, and any additional activities of nesting or hatchling sea turtles in the project area;

12. If any nesting turtles are sighted on the beach during daylight hours, construction activities must cease immediately until the turtle has returned to the water, and the sea turtle permit holder responsible for nest monitoring has marked any nest that may have been laid for avoidance;

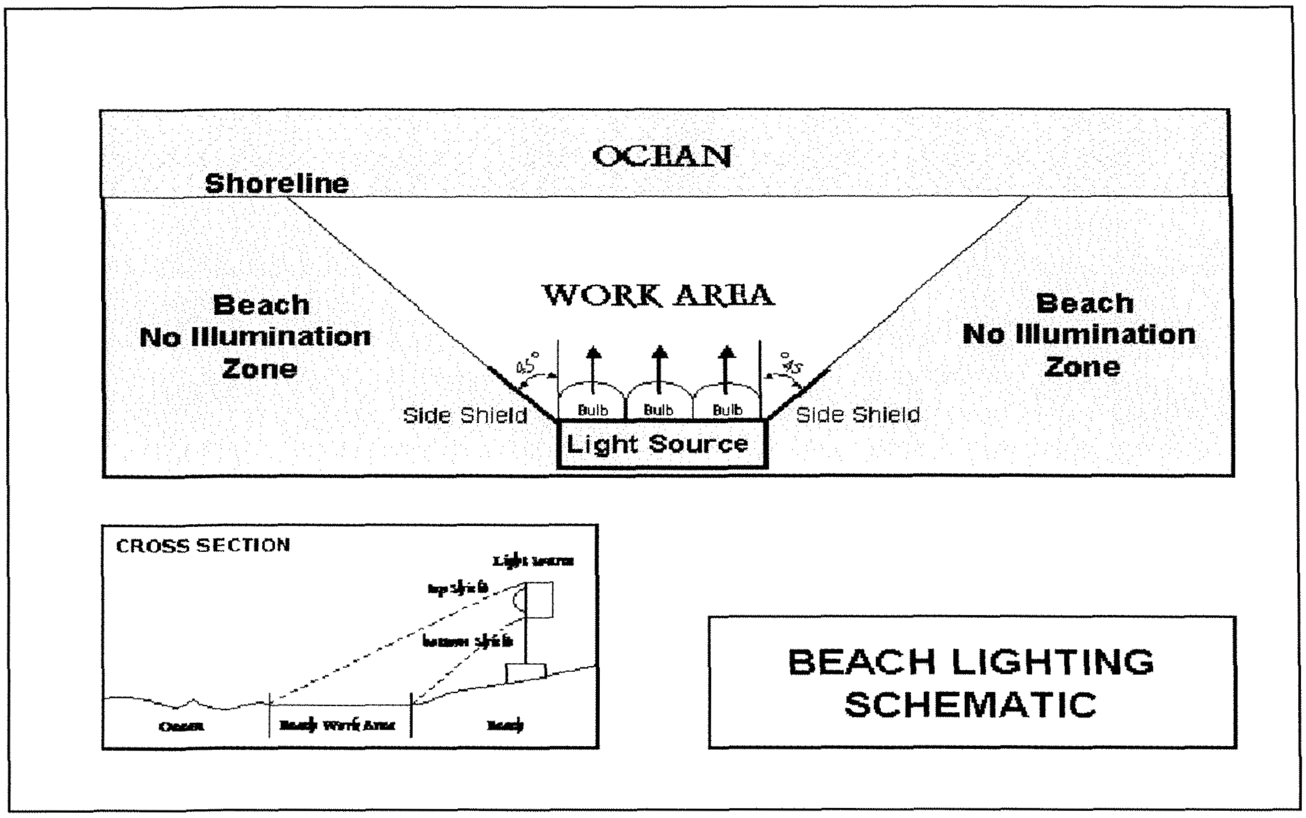

Figure 3. Beach lighting schematic

13. On-beach access to the construction site will be restricted to the wet sand below mean high water, except where passage is made impossible by the narrowness of the traversible beach seaward of existing revetments or upland development (primarily at high tide);

14. No permanent exterior lighting will be installed in association with this construction project;

15. If sand placement or sand accretion results in exposure of the T-heads landward of mean high water and/or artificial lighting problems exist in the vicinity of the T-groin structures, and it is determined that hatchlings are being trapped in the corners of the T-heads as a result, the applicant will notify the Corps and the Service immediately and the Corps and the Service will determine if additional actions are warranted;

16. In the event a T-groin structure fails or begins to disintegrate, all debris and structural material must be removed from the nesting beach area and deposited off-beach immediately. If maintenance of a T-groin structure is required during the period from April 1 to November 30, no work will be initiated without prior coordination with the South Florida Ecological Services Office; and

17. A report describing the actions taken to implement the terms and conditions of this incidental take statement shall be submitted to the South Florida Ecological Services Office, Vero Beach, within 60 days of completion of the proposed work for each year when the activity has occurred. This report will include the dates of actual construction activities, names and qualifications of personnel involved in nest surveys and relocation activities, descriptions and locations of self-release beach sites, nest survey and relocation results, and hatching success of nests.

The Service believes that incidental take will be limited to the 1.4 miles of beach that have been identified for sand placement and T-groin construction. The reasonable and prudent measures, with their implementing terms and conditions, are designed to minimize the impact of incidental take that might otherwise result from the proposed action. The Service believes that no more than the following types of incidental take will result from the proposed action: (1) destruction of all nests that may be constructed and eggs that may be deposited and missed by a nest survey and egg relocation program within the boundaries of the proposed project; (2) destruction of all nests deposited during the period when a nest survey and egg relocation program is not required to be in place within the boundaries of the proposed project; (3) reduced hatching success due to egg mortality during relocation and adverse conditions at the relocation site; (4) harassment in the form of disturbing or interfering with female turtles attempting to nest within the construction area or on adjacent beaches as a result of construction activities; (5) disorientation of hatchling sea turtles on beaches adjacent to the construction area as they emerge from the nest and crawl to the water as a result of project lighting; (6) behavior modification of nesting females due to escarpment formation resulting from the readjustment of renourishment beach profiles within the project area during a nesting season, resulting in false crawls or situations where they choose marginal or unsuitable nesting areas to deposit eggs; (7) destruction of nests from escarpment leveling within a nesting season when such leveling has been necessary due to escarpment formation resulting from the readjustment of a renourishment profile and approved by the Service; (8) behavior modification of nesting females or hatchlings due to the presence of the T-groins which may act as barriers to movement; and (9) behavior modification of nesting females if they dig into shallowly buried T-groins, resulting in false crawls or situations where they choose marginal or unsuitable nesting areas to deposit eggs.

The amount or extent of incidental take for sea turtles will be considered exceeded if the project results in more than a one-time placement of sand on the 1.4 miles of beach or the number of T-groins exceeds 10. If, during the course of the action, this level of incidental take is exceeded, such incidental take represents new information requiring reinitiation of consultation and review of the reasonable and prudent measures provided. The Federal agency must immediately provide an explanation of the causes of the taking and review with the Service the need for possible modification of the reasonable and prudent measures.

CONSERVATION RECOMMENDATIONS

Section 7(a)(1) of the ESA directs Federal agencies to utilize their authorities to further the purposes of the ESA by carrying out conservation programs for the benefit of endangered and threatened species. Conservation recommendations are discretionary agency activities to minimize or avoid adverse effects of a proposed action on listed species or critical habitat, to help implement recovery plans, or to develop information:

1. Construction activities for this project and similar future projects shall be planned to take place outside the sea turtle nesting and hatching season (April 1 to November 30);

2. Appropriate native salt-resistant dune vegetation should be established on restored dunes. The DEP, Office of Beaches and Coastal Systems, can provide technical assistance on the specifications for design and implementation;

3. Educational signs should be placed where appropriate at beach access points explaining the importance of the area to sea turtles and/or the life history of sea turtle species that nest in the area;

4. To better assess the effects of T-groins on nesting sea turtles and hatchlings, the Corps should direct the applicant to review the results of the Gasparilla T-groin project monitoring studies after one complete nesting season has taken place. Current construction schedules would indicate that this would be after the 2006 nesting season is complete. Lessons learned from that project should be applied to future T-groin projects; and

5. A shorebird monitoring program should be implemented for the action area. Very little information is available with respect to shorebird use of the site, although it is adjacent to designated critical habitat for the piping plover and piping plovers may use the site for roosting, loafing, or foraging. This monitoring program should be coordinated with Collier County's existing program to ensure that comparable data are collected.

In order for the Service to be kept informed of actions minimizing or avoiding adverse effects or benefiting listed species or their habitats, the Service requests notification of the implementation of any conservation recommendations.

REINITIATION - CLOSING STATEMENT

This concludes formal consultation on the action outlined in the request. As provided in 50 CFR §402.16, reinitiation of formal consultation is required where discretionary Federal agency involvement or control over the action has been retained (or is authorized by law) and if: (1) the amount or extent of incidental take is exceeded; (2) new information reveals effects of the agency action that may affect listed species or critical habitat in a manner or to an extent not considered in this opinion; (3) the agency action is subsequently modified in a manner that causes an effect to the listed species or critical habitat not considered in this opinion; or (4) a new species is listed or critical habitat designated that may be affected by the action. In instances where the amount or extent of incidental take is exceeded, any operations causing such take must cease pending reinitiation.

Thank you for your cooperation and effort in protecting fish and wildlife resources. Should you have any questions regarding the findings and recommendations contained in this document, please contact Trish Adams at 772-562-3909, extension 232.

Sincerely,

James J. Slack
Field Supervisor
South Florida Ecological Services Office

cc:
FWC, Protected Species, Tallahassee, Florida (Robbin Trindell)
DEP, Office of Beaches and Coastal Systems, Tallahassee, Florida
Service, Naples, Florida
Service, Jacksonville, Florida (Sandy MacPherson)
Collier County Natural Resources Division (Maura Kraus)
Collier County Public Utilities (Jim Mudded)

LITERATURE CITED

Ackerman, R.A. 1980. Physiological and ecological aspects of gas exchange by sea turtle eggs. Amer. Zool. 20:575-583.

Addison, D., M. Kraus, T. Doyle, and J. Ryder. 2000. An Overview of Marine Turtle Nesting Activity on Florida's Southwest Coast-Collier County, 1994-1999. Poster.

Alexander, J., S. Deishley, K. Garrett, W. Coles, and D. Dutton. 2002. Tagging and nesting research on leatherback sea turtles (*Dermochelys coriacea*) on Sandy Point, Saint Croix, U.S. Virgin Islands, 2002. Annual Report to the Fish and Wildlife Service. 41 pages.

Bowen, B.W. 1994. Letter dated November 17, 1994, to Sandy MacPherson, National Sea Turtle Coordinator, U.S. Fish and Wildlife Service, Jacksonville, Florida. University of Florida. Gainesville, Florida.

Bowen, B.W. 1995. Letter dated October 26, 1995, to Sandy MacPherson, National Sea Turtle Coordinator, U.S. Fish and Wildlife Service, Jacksonville, Florida. University of Florida. Gainesville, Florida.

Bowen, B., J.C. Avise, J.I. Richardson, A.B. Meylan, D. Margaritoulis, and S.R. Hopkins-Murphy. 1993. Population structure of loggerhead turtles (*Caretta caretta*) in the northwestern Atlantic Ocean and Mediterranean Sea. Cons. Biol. 7(4):834-844.

Coastal Engineering Research Center. 1984. Shore Protection Manual, Volumes I and II. U.S. Army Corps of Engineers Waterways Experiment Station, Vicksburg, Mississippi.

Collier County Natural Resources Department (CCNRD). January 2001. Collier County Sea Turtle Protection Plan. M.C. Kraus, P. Allman, and J. Seitz, principal investigators. Publication Series NR-SP-01-01, Collier County Community Development and Environmental Services, Naples, Florida.

Dean, C. 1999. Against the tide: the battle for America's beaches. Columbia University Press; New York, New York.

Dickerson, D.D. and D.A. Nelson. 1989. Recent results on hatchling orientation responses to light wavelengths and intensities. Pages 41-43 *in* Eckert, S.A., K.L. Eckert, and T.H. Richardson (compilers). Proceedings of the 9th Annual Workshop on Sea Turtle Conservation and Biology. NOAA Technical Memorandum NMFS-SEFC-232.

Dodd, C.K., Jr. 1988. Synopsis of the biological data on the loggerhead sea turtle *Caretta caretta* (Linnaeus 1758). U.S. Fish and Wildlife Service, Biological Report 88(14). 110pp.

Ehrhart, L.M. 1989. Status report of the loggerhead turtle. Pages 122-139 *in* Ogren, L., F. Berry, K. Bjorndal, H. Kumpf, R. Mast, G. Medina, H. Reichart, and R. Witham (eds.). Proceedings of the 2nd Western Atlantic Turtle Symposium. NOAA Technical Memorandum NMFS-SEFC-226.

Encalada, S.E., K.A. Bjorndal, A.B. Bolten, J.C. Zurita, B. Schroeder, E. Possardt, C.J. Sears, and B.W. Bowen. 1998. Population structure of loggerhead turtle (*Caretta caretta*) nesting colonies in the Atlantic and Mediterranean as inferred from mitochondrial DNA control region sequences. Marine Biology 130:567-575.

Ernest, R.G. and R.E. Martin. 1999. Martin County Beach Nourishment Project: Sea Turtle Monitoring and Studies. 1997 Annual Report and Final Assessment. Unpublished report to Florida Department of Environmental Protection. 96pp.

Fletemeyer, J. 1980. Sea turtle monitoring project. Unpublished report to Broward County Environmental Quality Control Board, Florida. 88pp.

Florida Department of Environmental Protection (DEP). 2001. Gasparilla Island beach restoration project, file number 0174403-001-JC, Lee County, Florida. Consolidated Notice of the Intent to Issue Joint Coastal Permit, Variance, and Authorization to Use Sovereign Submerged Lands

Florida Fish and Wildlife Conservation Commission (FWC). 2003. Nesting trends of Florida's sea turtles. Florida Marine Research Institute web page http://www.floridamarine.org/.

Florida Fish and Wildlife Conservation Commission (FWC). 2004. Fish and Wildlife Research Institute web page http://research.myfwc.com.

Glenn, L. 1998. The consequences of human manipulation of the coastal environment on hatchling loggerhead sea turtles (*Caretta caretta*, L.). Pages 58-59 *in* Byles, R., and Y. Fernandez (compilers). Proceedings of the Sixteenth Annual Symposium on Sea Turtle Biology and Conservation. NOAA Technical Memorandum NMFS-SEFSC-412.

Gyuris, E. 1994. The rate of predation by fishes on hatchling of the green turtle (*Chelonia mydas*). Coral Reefs 13: 137-144.

Hirth, H.F. 1997. Synopsis of the biological data on the green turtle *Chelonia mydas* (Linnaeus 1758). U.S. Fish and Wildlife Service, Biological Report 97(1). 120pp.

Hopkins, S.R. and J.I. Richardson, eds. 1984. Recovery plan for marine turtles. National Marine Fisheries Service, St. Petersburg, Florida. 355pp.

Howard, B. and P. Davis. 1999. Sea turtle nesting activity at Ocean Ridge in Palm Beach County, Florida, 1999. Unpublished report prepared for the Palm Beach County Department of Environmental Resources Management, West Palm Beach, Florida.

Humiston, K. 2001. Letter dated September 17, 2001, Trish Adams, Fish and Wildlife Biologist, U.S. Fish and Wildlife Service, Vero Beach, Florida. Gasparilla Island Erosion Control Project, JCP File No. 0174403-001-JC, H&M File No 9061. Humiston and Moore Engineers.

Humiston and Moore Engineers. 2000a. Hideaway Beach T-groins, 2-Year Post Construction Monitoring Report, March 2000.

Humiston and Moore Engineers. 2000b. North Captiva T-groin Erosion Control, 1st Annual Monitoring Report, February 2000.

Humiston and Moore Engineers. 2001a. Hideaway Beach T-groins, 3-Year Post Construction Monitoring Report.

Humiston and Moore Engineers. 2001b. First annual monitoring report South Naples erosion control Project (DEP permit No. 0147224-001 JC and Corps permit No. 199805167 IP-MN). Unpublished report prepared for the City of Naples, Lee County, Florida.

Kaufman, W. and O. Pilkey. 1979. The beaches are moving. Anchor Press/Doubleday; Garden City, New York.

Komar, P.D. 1983. Coastal erosion in response to the construction of jetties and breakwaters. Pages 191-204 *in* Komar, P.D. (editor). CRC Handbook of Coastal Processes and Erosion. CRC Press; Boca Raton, Florida.

LeBuff, C.R., Jr. 1990. The loggerhead turtle in the eastern Gulf of Mexico. Caretta Research, Incorporated, Sanibel Island, Florida. 236pp.

Lenarz, M.S., N.B. Frazer, M.S. Ralston, and R.B. Mast. 1981. Seven nests recorded for loggerhead turtle *(Caretta caretta)* in one season. Herpetological Review 12(1):9.

Leonard, L.A., T.D. Clayton, and O.H. Pilkey. 1990. An analysis of replenished beach design parameters on U.S. East Coast barrier islands. Journal of Coastal Research 6(1):15-36.

Limpus, C.J., V. Baker, and J.D. Miller. 1979. Movement induced mortality of loggerhead eggs. Herpetologica 35(4):335-338.

Limpus, C., J.D. Miller, and C.J. Parmenter. 1993. The northern Great Barrier Reef green turtle *Chelonia mydas* breeding population. Pages 47-50 *in* Smith, A.K. (compiler), K.H. Zevering and C.E. Zevering (editors). Raine Island and Environs Great Barrier Reef: Quest to Preserve a Fragile Outpost of Nature. Raine Island Corporation and Great Barrier Reef Marine Park Authority, Townsville, Queensland, Australia.

Mann, T.M. 1977. Impact of developed coastline on nesting and hatchling sea turtles in southeastern Florida. Unpublished M.S. thesis. Florida Atlantic University, Boca Raton, Florida. 100pp.

McDonald, D.L. and P.H. Dutton. 1996. Use of PIT tags and photoidentification to revise remigration estimates of leatherback turtles (*Dermochelys coriacea*) nesting in St. Croix, U.S. Virgin Islands, 1979-1995. Chelonian Conservation and Biology 2(2):148-152.

McGehee, M.A. 1990. Effects of moisture on eggs and hatchlings of loggerhead sea turtles (*Caretta caretta*). Herpetologica 46(3):251-258.

Meylan, A., B. Schroeder, and A. Mosier. 1995. Sea turtle nesting activity in the State of Florida 1979-1992. Florida Marine Research Publications Number 52, St. Petersburg, Florida. 51pp.

Miller, K., G.C. Packard, and M.J. Packard. 1987. Hydric conditions during incubation influence locomotor performance of hatchling snapping turtles. J. Exp. Biol. 127:401-412.

Moody, K. 1998. The effects of nest relocation on hatching success and emergence success of the loggerhead turtle (*Caretta caretta*) in Florida. Pages 107-108 *in* Byles, R. and Y. Fernandez (compilers). Proceedings of the Sixteenth Annual Symposium on Sea Turtle Biology and Conservation. NOAA Technical Memorandum NMFS-SEFSC-412.

Mrosovsky, N. and A. Carr. 1967. Preference for light of short wavelengths in hatchling green sea turtles (*Chelonia mydas*), tested on their natural nesting beaches. Behavior 28:217-231.

Mrosovsky, N. and S.J. Shettleworth. 1968. Wavelength preferences and brightness cues in water finding behavior of sea turtles. Behavior 32:211-257.

Murphy, T.M. and S.R. Hopkins. 1984. Aerial and ground surveys of marine turtle nesting beaches in the southeast region. Final report to NMFS-SEFC. 73pp.

National Marine Fisheries Service (NOAA Fisheries) and U.S. Fish and Wildlife Service (Service). 1991a. Recovery plan for U.S. population of Atlantic green turtle (*Chelonia mydas*). National Marine Fisheries Service, Washington, D.C. 52pp.

National Marine Fisheries Service (NOAA Fisheries) and U.S. Fish and Wildlife Service (Service). 1991b. Recovery plan for U.S. population of loggerhead turtle (*Caretta caretta*). National Marine Fisheries Service, Washington, D.C. 64pp.

National Marine Fisheries Service (NOAA Fisheries) and U.S. Fish and Wildlife Service (Service). 1992. Recovery plan for leatherback turtles (*Dermochelys coriacea*) in the U.S. Caribbean, Atlantic, and Gulf of Mexico. National Marine Fisheries Service, Washington, D.C. 65pp.

National Marine Fisheries Service (NOAA Fisheries) and U.S. Fish and Wildlife Service (Service). 1998. Recovery plan for U.S. Pacific populations of the green turtle (*Chelonia mydas*). National Marine Fisheries Service, Silver Spring, Maryland. 84 pages.

National Research Council. 1987. Responding to changes in sea level. Committee on Engineering Implications of Changes in Relative Mean Sea Level, Marine Board, Commission on Engineering and Technical Systems. National Academy Press; Washington, D.C

National Research Council. 1990. Decline of the sea turtles: causes and prevention. National Academy Press, Washington, D.C. 259pp.

National Research Council. 1995. Beach nourishment and protection. National Academy Press; Washington, D.C.

Nelson, D.A. 1987. The use of tilling to soften nourished beach sand consistency for nesting sea turtles. Unpublished report. U.S. Army Corps of Engineers Waterways Experiment Station, Vicksburg, Mississippi. 15pp.

Nelson, D.A. 1988. Life history and environmental requirements of loggerhead turtles. U.S. Fish and Wildlife Service Biological Report 88(23). U.S. Army Corps of Engineers TR EL-86-2 (Rev.). 34pp.

Nelson, D.A., and B. Blihovde. 1998. Nesting sea turtle response to beach scarps. Page 113 *in* Byles, R., and Y. Fernandez (compilers). Proceedings of the Sixteenth Annual Symposium on Sea Turtle Biology and Conservation. NOAA Technical Memorandum NMFS-SEFSC-412.

Nelson, D.A. and D.D. Dickerson. 1987. Correlation of loggerhead turtle nest digging times with beach sand consistency. Abstract of the 7th Annual Workshop on Sea Turtle Conservation and Biology.

Nelson, D.A. and D.D. Dickerson. 1988a. Effects of beach nourishment on sea turtles. *In* Tait, L.S. (ed.). Proceedings of the Beach Preservation Technology Conference '88. Florida Shore & Beach Preservation Association, Incorporated, Tallahassee, Florida.

Nelson, D.A. and D.D. Dickerson. 1988b. Hardness of nourished and natural sea turtle nesting beaches on the east coast of Florida. Unpublished report. U.S. Army Corps of Engineers Waterways Experiment Station, Vicksburg, Mississippi. 27pp.

Nelson, D.A. and D.D. Dickerson. 1988c. Response of nesting sea turtles to tilling of compacted beaches, Jupiter Island, Florida. Unpublished report. U.S. Army Corps of Engineers Waterways Experiment Station, Vicksburg, Mississippi. 26pp.

Nelson, D.A., K. Mauck, and J. Fletemeyer. 1987. Physical effects of beach nourishment on sea turtle nesting, Delray Beach, Florida. Technical Report EL-87-15. U.S. Army Corps of Engineers Waterways Experiment Station, Vicksburg, Mississippi. 56pp.

Packard, G.C., M.J. Packard, and T.J. Boardman. 1984. Influence of hydration of the environment on the pattern of nitrogen excretion by embryonic snapping turtles (*Chelydra serpentina*). J. Exp. Biol. 108:195-204.

Packard, G.C., M.J. Packard, and W.H.N. Gutzke. 1985. Influence of hydration of the environment on eggs and embryos of the terrestrial turtle *Terrapene ornata*. Physiol. Zool. 58(5):564-575.

Packard,G.C., M.J. Packard, T.J. Boardman, and M.D. Ashen. 1981. Possible adaptive value of water exchange in flexible-shelled eggs of turtles. Science 213:471-473.

Packard, G.C., M.J. Packard, K. Miller, and T.J. Boardman. 1988. Effects of temperature and moisture during incubation on carcass composition of hatchling snapping turtles (*Chelydra serpentina*). J. Comp. Physiol. B. 158:117-125.

Packard, M.J. and G.C. Packard. 1986. Effect of water balance on growth and calcium mobilization of embryonic painted turtles (*Chrysemys picta*). Physiol. Zool. 59(4):398-405.

Parmenter, C.J. 1980. Incubation of the eggs of the green sea turtle, *Chelonia mydas*, in Torres Strait, Australia: the effect of movement on hatchability. Aust. Wildl. Res. 7:487-491.

Pearce, A.F. 2001. Contrasting population structure of the loggerhead turtle (*Caretta caretta*) using mitochondrial and nuclear DNA markers. M.S. Thesis. University of Florida, Gainesville, Florida.

Philbosian, R. 1976. Disorientation of hawksbill turtle hatchlings (*Eretmochelys imbricata*) by stadium lights. Copeia 1976:824.

Pilcher, J.J., S. Enderby, T. Stringell, and L. Bateman. 2000. Nearshore turtle hatchling distribution and predation in Sabah, Malaysia. Pages 7-31 *in* Kalb, H.J. and T. Wibbels (compilers). Proceedings of the Nineteenth Annual Symposium on Sea Turtle Biology and Conservation. U.S. Department of Commerce NOAA Technical Memorandum NMFS-SEFSC-443.

Pilkey, O.H. and K.L. Dixon. 1996. The Corps and the shore. Island Press; Washington, D.C.

Pritchard, P.C.H. 1992. Leatherback turtle *Dermochelys coriacea*. Pages 214-218 *in* Moler, P.E. (ed.). Rare and Endangered Biota of Florida, Volume III. University Press of Florida, Gainesville, Florida.

Raymond, P.W. 1984. The effects of beach restoration on marine turtles nesting in south Brevard County, Florida. Unpublished M.S. Thesis. University of Central Florida, Orlando, Florida. 121pp.

Richardson, J.I. and T.H. Richardson. 1982. An experimental population model for the loggerhead sea turtle (*Caretta caretta*). Pages 165-176 *in* Bjorndal, K.A. (ed.). Biology and Conservation of Sea Turtles. Smithsonian Institution Press, Washington, D.C.

Ross, J.P. 1982. Historical decline of loggerhead, ridley, and leatherback sea turtles. Pages 189-195 *in* Bjorndal, K.A. (ed.). Biology and Conservation of Sea Turtles. Smithsonian Institution Press, Washington, D.C.

Ross, J.P. and M.A. Barwani. 1995. Review of sea turtles in the Arabian area. Pages 373-383 *in* Bjorndal, K.A. (editor). Biology and Conservation of Sea Turtles, Revised Edition. Smithsonian Institution Press, Washington, D.C. 615 pages.

Salmon, M. and J. Wyneken. 1987. Orientation and swimming behavior of hatchlings loggerhead turtles (*Caretta caretta L*) during their offshore migration. J. Exp. Marine Biol. Ecology. 109:137-153.

Schroeder, B.A. 1994. Florida index nesting beach surveys: Are we on the right track? Pages 132-133 *in* Bjorndal, K.A., A.B. Bolten, D.A. Johnson, and P.J. Eliazar (compilers). Proceedings of the 14th Annual Symposium on Sea Turtle Biology and Conservation. NOAA Technical Memorandum NMFS-SEFSC-351.

Spotila, J.R., E.A. Standora, S.J. Morreale, G.J. Ruiz, and C. Puccia. 1983. Methodology for the study of temperature related phenomena affecting sea turtle eggs. U.S. Fish and Wildlife Service Endangered Species Report 11. 51pp.

Spotila, J.R., A.E. Dunham, A.J. Leslie, A.C. Steyermark, P.T. Plotkin, and F.V. Paladino. 1996. Worldwide population decline of *Dermochelys coriacea*: are leatherback turtles going extinct? Chelonian Conservation and Biology 2(2):290-222.

Stancyk, S.E. 1995. Non-human predators of sea turtles and their control. Pages 139-152 *in* Bjorndal, K.A. (editor). Biology and Conservation of Sea Turtles. Smithsonian Institution Press; Washington, D.C.

Talbert, O.R., Jr., S.E. Stancyk, J.M. Dean, and J.M. Will. 1980. Nesting activity of the loggerhead turtle (*Caretta caretta*) in South Carolina I: A rookery in transition. Copeia 1980(4):709-718.

Turtle Expert Working Group. 1998. An assessment of the Kemp's ridley (*Lepidochelys kempii*) and loggerhead (*Caretta caretta*) sea turtle populations in the western North Atlantic. NOAA Technical Memorandum NMFS-SEFSC-409.

Turtle Expert Working Group. 2000. Assessment update for the Kemp's ridley and loggerhead sea turtle populations in the western North Atlantic. NOAA Technical Memorandum NMFS-SEFSC-444.

U.S. Army Corps of Engineers (Corps). 1992. Preliminary draft feasibility report/ environmental impact statement. Glynn County beaches, Georgia. Hurricane and storm damage reduction study. Unpublished manuscript.

Witherington, B.E. 1991. Orientation of hatchling loggerhead turtles at sea off artificially lighted and dark beaches. J. Exp. Mar. Bio. Ecol. 149:1-11.

Witherington, B.E. 1992. Behavioral responses of nesting sea turtles to artificial lighting. Herpetologica 48:31-39.

Witherington, B.E. and K.A. Bjorndal. 1991. Influences of artificial lighting on the seaward orientation of hatchling loggerhead turtles (*Caretta caretta*). Biol. Cons. 55:139-149.

Witherington, B.E. and L.M. Ehrhart. 1989. Status and reproductive characteristics of green turtles (*Chelonia mydas*) nesting in Florida. Pages 351-352 *in* Ogren, L., F. Berry, K. Bjorndal, H. Kumpf, R. Mast, G. Medina, H. Reichart, and R. Witham (eds). Proceedings of the Second Western Atlantic Turtle Symposium. NOAA Tech. Memo. NMFS-SEFC-226.

Witherington, B.E. and M. Salmon. 1992. Predation on loggerhead turtle hatchlings after entering the sea. Journal of Herpetology, Volume 26, No. 2, pp 226-228

Wyneken J. and M. Salmon. 1996. Aquatic predation, fish densities, and potential threats to sea turtle hatchlings from open-beach hatcheries: Final Report. Technical Report 96-04, Florida Atlantic University, Boca Raton, Florida.

Wyneken, J., L. DeCarlo, L. Glenn, M. Salmon, D. Davidson, S. Weege., and L. Fisher. 1998. On the consequences of timing, location and fish for hatchlings leaving open beach hatcheries. Pages 155-156 *in* Byles, R. and Y. Fernandez (compilers). Proceedings of the Sixteenth Annual Symposium on Sea Turtle Biology and Conservation. NOAA Technical Memorandum NMFS-SEFSC-412.

Wyneken, J., L. Fisher, M. Salmon, S. Weege. 2000. Managing relocated sea turtle nests in open-beach hatcheries. Lessons in hatchery design and implementation in Hillsboro Beach, Broward County, Florida. *In*: Kalb, H.J. and T. Wibblels, compilers. Proceedings of the Nineteen Annual Symposium on Sea Turtle Biology and Conservation. U.S. Department of Commerce. NOAA Technical Memorandum NMFS-SEFSC-443, pp 193-194

Wyneken J., M. Salmon, M. Lohmann, and K.J. Lohmann. 1990. Orientation by hatchling loggerhead sea turtles (*Caretta carretta L.*) in a wave tank. J. Exp. Mar. Biol. Ecol. 139:43-50

Zug, G.R. and J.F. Parham. 1996. Age and growth in leatherback turtles, *Dermochelys coriacea* (Testidines: Dermochelyidae): A skeletochronological analysis. Chelonian Conservation and Biology 2(2):244-249.